KAUNAS UNIVERSITY OF TECHNOLOGY

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FACTORS INFLUENCING THE PERFORMANCE OF TECHNOLOGY TRANSFER OFFICES

MASTER'S THESIS

Supervisor: Assoc. prof. Dr. Lina Užienė

KAUNAS, 2018

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Innovation Management and Entrepreneurship (621N20011)

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DECLARATION OF ACADEMIC INTEGRITY

15 May 2018

Kaunas

I, **Rūta Žmuidzinaitė**, hereby confirm that Master's Thesis entitled "*Factors Influencing the Performance of Technology Transfer Offices*" is solely my own work and all the data and research findings presented are true and obtained fairly. None of the thesis parts contain plagiarised material from printed or internet sources, all direct or indirect quotes of other sources are fully and properly acknowledged. I have not made illegal payments for this work to anyone.

I understand that in case of dishonesty I will be subject to penalties in accordance with the procedure established by Kaunas University of Technology.

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Socialiniai mokslai: 03 S Vadyba ir administravimas
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Kaunas, 2018. 110 p.

SANTRAUKA

Temos aktualumas. Žinių ekonomikoje nematerialusis turtas tapo pagrindiniu veiksniu, darančiu įtaką šalių vystymuisi. Tradicinis požiūris į universitetus kaip į švietimo ir mokslo institucijas keičiasi, ir šiai dienai universitetai yra ne tik žinių ir technologijų kūrėjai, bet tampa platformomis, kuriose yra perduodami technologiniai sprendimai siekiant ekonominės naudos visuomenei (Ustundag ir kt., 2011). Dėl šios priežasties mokslo ir verslo bendradarbiavimo svarba yra plačiai nagrinėjama ir literatūroje (Lambert, 2003; Siegel ir kt., 2003b; Salter ir kt., 2009). Šiandien daugelyje šalių yra aktyviai vykdomos nacionalinės iniciatyvos verslo-mokslo bendradarbiavimui skatinti bei kuriamos priemonės mokslinių tyrimų ir eksperimentinės plėtros veikloms vykdyti. Viena iš tokių priemonių - technologijų perdavimo centrai (TPC). Deja, vieni TPC yra sėkmingesni už kitus, o pastarųjų potencialas nėra išnaudojamas maksimaliai (Secundo ir kt., 2016). Iki šių dienų daugumoje atliktų studijų, kurių metu buvo vertinamas TPC efektyvumas, mokslininkai rėmėsi finansiniais rodikliais (Carlsson ir Fridh, 2002; Chapple ir kt., 2005; Siegel ir kt., 2007; Kim ir kt., 2008; Curi ir kt., 2012; Vinig ir Lips, 2015) ir tik keletas tyrimų buvo atlikta naudojant ne finansinius (Thursby ir kt., 2001; Secundo ir Elia, 2014). Pasak autorių Granieri ir Frederick (2016), rodikliai neatskleidžia priežasčių, kodėl ir kaip yra veikiamas TPC rezultatyvumas, o tik parodo, kuriame lygmenyje technologijų perdavimo centras veikia tam tikru momentu. Dėl to norint atskleisti TPC rezultatyvumo veiklų priežastingumą reikia identifikuoti veiksnius, kurie tam turi didžiausios įtakos.

Problematika. Lietuvai įsipareigojus įgyvendinti strategijos „Europa 2020" tikslus buvo nustatyti atitinkami nacionaliniai tikslai. Tačiau, remiantis Europos Komisijos pateikta informacija, Lietuva susiduria su keletu pagrindinių iššūkių, siekiant įgyvendinant inovacijų politiką: i) efektyvumo stoka viešųjų mokslinių tyrimų ir eksperimentinės plėtros (MTEP) sistemoje; ii) nepakankamas mokslinių tyrimų rezultatų komercializavimo skatinimas; iii) vieningos vyriausybės sistemos ir inovacijų proceso rėmimo politikos trūkumas. Lietuvoje veikiantys TPC buvo įsteigti visai neseniai,

todėl yra sudėtinga įvertinti, ar visi jie padeda greičiau ir efektyviau identifikuoti mokslinius išradimus bei patekti į komercializavimo procesą. Pasak mokslininkų (Heher, 2006; Anderson ir kt., 2007; Oliveira ir Teixeira, 2010), rezultatai iš investicijų į mokslinius tyrimus ir technologijų perdavimą universitete gali užtrukti iki 10 metų organizaciniame lygmenyje ir net 20 - nacionaliniame. Todėl norint suprasti platesnę ir įvairesnę TPC veiklos perspektyvą ir iš anksto įgyti žinių, svarbu atlikti tarptautinį tyrimą, kuriame būtų identifikuoti veiksniai, darantys įtaką Europoje veikiančių TPC rezultatyvumui.

Tyrimo tikslas - pagrįsti veiksnius, darančius įtaką technologijų perdavimo centrų rezultatyvumui.

Tyrimo objektas - veiksniai, darantys įtaką technologijų perdavimo centrų rezultatyvumui.

Darbo uždaviniai:

1. Ištirti teorines ir praktines technologijų perdavimo centrų rezultatyvumo prielaidas;
2. sudaryti empirinio tyrimo metodologiją;
3. remiantis sudaryta empirinio tyrimo metodologija atlikti tyrimą ir pagrįsti jo rezultatus.

Metodologija. Tyrimas atliktas remiantis mokslinės literatūros analize ir kokybine prieiga. Teorinė analizė naudota nustatyti veiksnius, kurie galimai daro įtaką technologijų perdavimo centrų rezultatyvumui. Kokybinė tyrimo prieiga buvo naudojama empirinio tyrimo atlikimui. Kokybinio tyrimo metu buvo naudojami keli metodai: atvejo analizė (vizitas į TPC Linkoping universitete Švedijoje), struktūrizuoti interviu su Europos novatoriškų universitetų konsorciumo (ECIU) TPC atstovais bei pusiau-struktūrizuoti interviu su ECIU TPC vadovais.

Pagrindiniai tyrimo rezultatai:

- Tyrimo metu identifikuoti penki pagrindiniai veiksniai, darantys įtaką TPC rezultatyvumui: i) investuotojai; ii) TPC strategija; iii) ryšių kūrimas; iv) TPC padalinys, dirbantis su įmonėmis; v) TPC darbuotojų verslo patirtis.
- Buvo pagrįsti identifikuoti veiksniai tarptautiniame kontekste.
- Atliktas tyrimas atskleidė, jog nepaisant TPC brandos lygio bei šalies, visur yra susiduriama su panašiais iššūkiais, siekiant sėkmingo technologijų perdavimo proceso.

Poster based on the results of this Master's Thesis accepted for presentation at **University-Industry Interaction Conference** on 20-22nd of June 2018 in London, UK.

Agenda of the Conference: https://www.university-industry.com/index/schedule

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ABBREVIATIONS

CEO - Chief Executive Officer

DEA - data envelopment analysis

ECIU - European Consortium of Innovative Universities

EU - European Union

EC European Commission

FCM - fuzzy cognitive maps

GDP - Gross domestic product

GROW - model developed in the 1980s by business coaches Graham Alexander, Alan Fine, and Sir John Whitmore

IEUA - University of Aveiro Business Incubator

INVEGA - Investment and Business Guarantees

IPR - Intellectual Property Rights

KPIs - Key Performance Indicators

KTU - Kaunas University of Technology

LIC - Lithuanian Innovation Center

LiU - Linkoping University

LSMU - Lithuanian University of Health Sciences

MBA - Master of Business Administration

MITA - Research, Innovation and Technology Agency

MOSTA - Research and Higher Education Monitoring and Analysis Center

NABC - method from Stanford Research Institute

RISE - The Swedish Research Institute

R&D - Research and Development

SDGs - Sustainable Development Goals

SMEs - Small and medium enterprises

TFP - total factor productivity

TTO - Technology Transfer Office

TUHH - Hamburg University of Technology

TUT - Tampere University of Technology

UA - University of Aveiro

UATEC - Technology Transfer Unit

UK - United Kingdom

US - United States

UT - University of Twente

UTEN - University Technology Enterprise Network

VGTU - Vilnius Gediminas Technology University

VINNOVA - Sweden’s Innovation Agency

VU - Vilnius University

DEFINITIONS

Business = enterprise = industry - commercial activity (English Oxford Living Dictionaries, 2018).

Intellectual property rights (IPR) - refers to creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce. IP is protected in law by, for example, patents, copyright and trademarks, which enable people to earn recognition or financial benefit from what they invent or create (WIPO, 2018).

Invention - is a new solution to a technical problem and can be protected through patents. Patents protect the interests of inventors whose technologies are truly groundbreaking and commercially successful, by ensuring that an inventor can control the commercial use of their invention (WIPO, 2018).

Key performance indicators (KPIs) - are a set of quantifiable measures that an organization uses to gauge its performance over time. These metrics are used to determine an organization's progress in achieving its strategic and operational goals, and also to compare an organization's finances and performance against other players within its field (based on Investopedia, 2018).

Licensing agreement - is a partnership between an intellectual property rights owner (licensor) and another who is authorized to use such rights (licensee) in exchange for an agreed payment (fee or royalty). A variety of such licensing agreements are available, which may be broadly categorized as follows: Technology License Agreement, Trademark Licensing and Franchising Agreement, Copyright License Agreement (WIPO, 2018).

Monetary key performance indicators - are generally based on income statement or balance sheet components, and may also report changes in income growth (CGMA, 2018).

Non-monetary key performance indicators - are other measures used to assess the activities that an organization sees as important to the achievement of its strategic objectives (CGMA, 2018).

Patent - is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. To get a patent, technical information about the invention must be disclosed to the public in a patent application (WIPO, 2018).

Performance of technology transfer offices (TTOs) - the action or process of performing a task or function at technology transfer office (English Oxford Living Dictionaries, 2018).

Reasoning - the action of argumentation in a logical, sensible way (based on English Oxford Living Dictionaries, 2018).

Research and innovation (R&I) = research and development (R&D) - work directed towards the innovation, introduction, and improvement of products and processes (English Oxford Living Dictionaries, 2018).

Scientist = researcher - a person who carries out academic or scientific research (English Oxford Living Dictionaries, 2018).

Spin-off - a new company that works at university newly created on the basis of intellectual property (based on Shane, 2004).

Start-up - a young company that is just beginning to develop. Startups are usually small and initially financed and operated by a handful of founders or one individual. These companies offer a product or service that is not currently being offered elsewhere in the market, or that the founders believe is being offered in an inferior manner (based on Investopedia, 2018).

Success factors - the combination of important facts that is required in order to accomplish one or more desirable goals (Business Dictionary, 2018).

Technology transfer office (TTO) - an intermediary between academia and industry, ensuring resources for the development and exploitation of university's intellectual property by recognizing potentially commercializable inventions and identifying licensees and/or investors for them (based on Weckowska, 2014).

INTRODUCTION

Research relevance: In the knowledge economy intangible assets became a key factor in the development of countries. Therefore, in order to emphasize the importance of technology innovations which increase national competitiveness countries need to reconsider their approach (Secundo et al., 2016). Nowadays modern universities are facing new challenges while adjusting themselves to a more integrated model that meets the economic requirements of current societies. The traditional way of thinking about universities as the sources of science and technology is changing. In recent years, academic institutions have gone from being an arena for knowledge and technology creation to a platform for transferring them to industrial and economic spheres (Ustundag et al., 2011). Therefore, the significant importance of university-business collaboration is emphasized generally in the literature (Lambert, 2003; Siegel et al., 2003b; Salter et al., 2009).

In order to facilitate such a process a crucial tool has been established - the *Technology Transfer Offices (TTOs).* As for today, TTO is a formal mechanism responsible for the protection of university-based intellectual property rights (IPR) and commercialization process of the inventions created at the university (Vining & Lips, 2015). TTOs are often considered as the main factor to result in the success of university and other related institutions (Chapple et al., 2005). Policy makers are increasingly starting to reconsider the activities of such offices in order to develop a system for TTOs to function efficiently (Curi et al., 2012). According to Siegel et al. (2003), the main objectives of TTOs are to proceed through activities that include the scientific discovery, invention disclosure, evaluation of the invention for patenting, patent application, marketing of technology, negotiation of license and licensing to firm. Launching a new venture (start-up or spin-off) is also considered as a possible result of such process (Tseng & Raudensky, 2014).

Despite the fact that national systems for research and innovation are more integrative in the process of increasing the importance of university-industry collaboration, academic units are still not equally successful in commercializing their knowledge (Secundo et al., 2016). Thus, there are many considerations if the main key factors influencing the performance of TTOs can be identified and distinguished.

Till today most of the studies measured the efficiency of TTOs while identifying outcomes through focusing on monetary key performance indicators (KPIs) (Carlsson & Fridh, 2002; Chapple et al., 2005; Siegel et al., 2007; Kim et al., 2008; Curi et al., 2012; Vinig & Lips, 2015), and only several studies evaluated non-monetary ones (Thursby et al., 2001; Secundo & Elia, 2014). According to Granieri and Frederick (2013), these indicators do not identify the performance of TTOs - they just reveal at what level the organization's performance is at a certain time. Thus, in order to determine the reasoning of the performance of TTOs, the factors influencing it need to be identified. Various scholars

have studied such factors so far (Ustundag et al., 2011; Caldera & Debande, 2010; Chapple et al., 2005; Hulsbeck et al., 2013), however, there is a lack of studies investigating the reasoning of those factors. Moreover, the biggest amount of researches were processed based on the U.S. data (Shane, 2004; Thursby & Kemp, 2002; Thursby & Thursby, 2002; Siegel, Waldman & Link, 2003, Lockett & Wright, 2005; Anderson, Daim & Lavoie, 2007; Kim, Anderson & Daim, 2008; Heisey and Adelman 2011; Tahvanainen & Hermans, 2011; York, 2012; Tseng & Raudensky, 2014) while the number of studies conducted about the European countries is much more limited. Furthermore, the fact that there are only several researches conducted in which the context of TTOs is compared in different countries (the UK and the U.S. case by Siegel et al., 2008; German and Swedish case by Sellenthin, 2009; Portuguese and Spanish case by Arqué-Castells et al., 2016) reveals the gap of cross-country studies on the performance of TTOs. Therefore, there is a need to conduct cross-country study implying the reasoning of the factors influencing the performance of TTOs based in Europe.

Research problem: According to the European Innovation Scoreboard (2017), Lithuania is among the so-called *Moderate Innovators*. Meanwhile Global Innovation Index reveals that Innovation Efficiency Ratio in Lithuania is ranked in 84th place out of 127. Therefore, the European Commission (EC) points out the most important challenges which Lithuania is facing while improving its innovation performance:

1. *The low efficiency of the public research and development (R&D) system.* So far Lithuania is among the countries which invested the most into R&D infrastructure but not the knowledge transfer. For instance, recently established five science and business centers are mainly serving as rental places even though they are also assigned to the other functions, i.e., the technology transfer and the commercialization of the results of scientific researches;
2. *the need to stimulate the commercialization of research results.* For this reason, R&D open access centers were established in Lithuania. Business companies were expected to use scientific equipment through these centers. However, during 2012-2015 the average load of them was only 44%, and thus they did not attract business as it was planned;
3. *the need of united government system and a policy to support the process of innovation.* Due to the delayed processes related to the Ministry of Finance, the objectives of the measures of Ministry of Education and Science were not achieved. In 2015 there were 10 joint initiatives of research and business planned, but at the end of 2016 there were no calls for such proposals announced.

Lithuania as a country has committed to achieve the goals of the *Strategy Europe 2020* and has set national targets accordingly. In 28 November 2012 Government of the Republic of Lithuania approved the *National Progress Strategy*. 2014-2020 the National Progress Strategy was drafted in order to implement the *Lithuania's Progress Strategy Lithuania 2030*. The latter includes five objectives for innovation, social inclusion, employment, education, climate and energy. Since the innovation is the priority in the Strategy Europe 2020, huge efforts have been allocated to stimulate science and business cooperation in Lithuania. For instance, during the period of 2013 - 2014 first technology transfer offices were established in the biggest Lithuanian universities, such as Vilnius Gediminas Technical University (VGTU), Kaunas University of Technology (KTU), Vilnius University (VU) and Lithuanian University of Health Sciences (LSMU). Their purpose is to transfer the novel knowledge created by the scientists to the society. As for today, all these TTOs are new and not mature, thus it is quite difficult to assess whether all of them is contributing to faster and more efficient identification of scientific invention and process of commercialization. According to the scholars (Heher, 2006; Anderson et al., 2007; Oliveira & Teixeira, 2010), **for TTO to attain positive results of return from an investment in research and technology transfer at the university can take up to 10 years on organizational level and 20 - on national.** Therefore, in order to understand broader and more varied perspective on the performance of TTOs and to get knowledge beforehand, it is relevant to conduct cross-country study implying the reasoning of the factors influencing the performance of TTOs based in Europe. Consequently, as one of Lithuanian TTOs was recently established at the university which is the member of the European Consortium of Innovative Universities (ECIU), the context of ECIU is suitable for this study.

Research aim: to reason the factors influencing the performance of TTOs.

Research object: factors influencing the performance of TTOs.

Research tasks:

1. To investigate theoretical and practical presumptions of the performance of TTOs;
2. to develop a research methodology;
3. to perform an empirical study and, based on the results, to reason it.

Research design:

Theoretical research: scientific literature analysis and synthesis.

Empirical research:

- case study;

- structured interviews with the representatives of TTOs at the members of ECIU;
- semi-structured interviews with the leaders of TTOs at the members of ECIU.

This study was conducted by two students in joint efforts. Focus of Sandra Žalgevičienė was more on the case analysis of TTOs at Linkoping University, University of Aveiro and Aalborg University. Rūta Žmuidzinaitė more concentrated on the case analysis of TTOs at Tampere University of Technology, Hamburg University of Technology and University of Twente. All other parts of the study were written together in synergy.

1. RELEVANCE AND REASONING OF THE PROBLEMATIC ASPECTS

One of the main goals set up in Lithuanian progress strategy “Lithuania 2030” is aiming to implement a smart economy, and one of the more important criteria for this implementation is that over the next 15 years Lithuania should be not lower than on the 10th position on innovativeness, research funding, number of patents and other indicators related to business and science cooperation. Close cooperation between science and business is an essential precondition for promoting country's progress, innovation, economic growth, competitiveness and public welfare. However, according to the Research and Innovation analysis in the European Semester Country Reports 2017, Lithuania faces numerous challenges to improve its innovation performance. In particular, the low efficiency of the public R&D system, the need to incentivize the commercialization of research results as well as the urgency to foster a governance system and a policy mix that are supportive of innovation.

It is widely accepted that economic growth depends on the productivity of knowledge use (Vinig & Lips, 2015). Unfortunately, **according to Global Innovation Index (2017), knowledge absorption and diffusion is low in Lithuania** (respectively 103 and 66 in ranking out of 127). In terms of knowledge and technology transfer process, which is an actual diffusion of absorbed knowledge, Lithuania is 20 years behind comparing to the other Western countries. In these countries significant intellectual changes in ownership regulation of science and educational institutions were made, new specialized or separate units were created involving professional teams working with technology transfer processes and having clearly defined business models and desired results.

In the mentioned countries at the governmental level the further development and commercialization of the inventions created in science and study institutions were stimulated by setting up independent financial funds (Kurgonaitė, 2015). Meanwhile, in Lithuania only in the past couple years the initiatives towards that direction were started to be taken. By participating in the projects implemented in science and business centers, changing regulations related with intellectual property, establishing open access centers and restructuring the scientific departments into more specialized units responsible for the commercialization of the inventions, the science and study institutions initiated the base for more effective collaboration between science and industry. State support for the development of innovation is a broad concept that covers many different aspects. Support for the development of innovation should be understood as a toolbox of state measures aimed to facilitate access to finances, encourage the regulations of innovation activities, stimulate the demand for innovation, strengthen communication between research institutions and the private sector (Skeberdytė, 2016). According to Jakubavičius (2008), *the innovation system is defined as the whole set of elements and interactions mechanisms that create the preconditions for the transformation of knowledge into new products and*

services. This system can be divided into three levels: innovation policy; innovation infrastructure; the company. All these levels are interlinked. Innovation policy is a relatively new area of public policy, and therefore, the state seeks to deliberately influence innovation processes by using a combination of instruments (Jakubavičius, 2008).

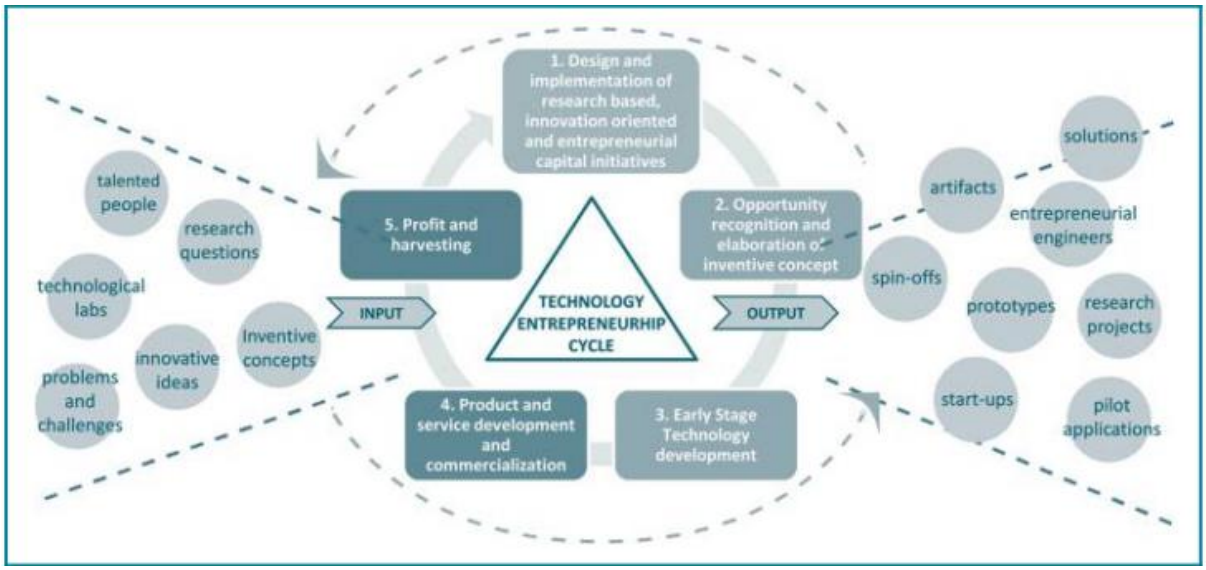

Figure 1. A process-based model for academic entrepreneurship performance

Levels of Lithuanian innovation policy and governance include the highest state institutions that shape innovation policy and its public management, and are mainly based on the regulatory spheres of the Ministry of Economy and the Ministry of Education and Science. **The implementation of Lithuanian innovation policy is managed by the Ministry of Economy**, which is responsible for innovation in business, **and the Ministry of Education and Science** which is in control of the growth of innovation potential, research development and partly - the commercialization of scientific results. The role of innovation support organizations is also important in this area (Lithuanian Innovation Development Action plan 2014-2020).

During the last 10 years five integrated science and business centers were created aiming i) to set up the infrastructure for carrying out public and private research, establishing knowledgeable enterprises and providing knowledge-intensive services; ii) to create a scientific environment for the commercialization of research results, technology transfer and interaction among science, studies and business; iii) to create conditions for increasing the competitiveness of Lithuanian science and technology in the international market. Based on these goals, 20 infrastructural projects for creation and renewal of these science and business centers were implemented which were equal to almost 300 million Euro investment. **According to Public Audit Report (2017), Lithuania is among the countries which invested the most into R&D infrastructure (26% in 2012 while the average of the EU is 7%)**.

However, so far these investments have not paid off as it was planned. For instance, **R&D open access centers were established** in order for business companies to be able to use scientific equipment, however **during 2012-2015 the average load of these centers were only 44%** and so they did not attract business as it was planned. Moreover, **it is concluded in the same Report that the five established science and business centers are mainly serving as rental places** even though they are also assigned to the other functions, i.e., the technology transfer and the commercialization of the results of scientific researches. Therefore, it is not surprising that knowledge absorption and diffusion ranking in Lithuania is so low, as the main investments are injected into affectless infrastructure but not the competence and knowledge.

Despite that, **in Lithuania the network of innovation support organizations consists of a large number of organizations**: integrated science, business and studies centers; Lithuanian Science Council; Association of Business Angels; Investment and Business Guarantees (INVEGA); Enterprise Lithuania; Research, Innovation and Technology Agency (MITA). The main activities of them are to provide innovation support services to companies and organizations that develop and implement innovations. According to Skeberdytė (2016), innovation support services can be divided into the following main groups: 1) information on technological development; 2) business consulting; 3) consultations on the issues related to the support of EU Structural Funds; 4) training, organization of scientific trips, traineeships; 5) financing of innovation projects, administration of funds; 6) search for partners, investors; 7) infrastructural services; 8) patenting and licensing; 9) transfer of knowledge and technology.

Since the establishment in 2010 **MITA has been the main state institution responsible for implementing innovation policy in the country**. MITA provides free services to business, academia, industry and the public sector which are interested in opportunities for international partnerships and national support for technology and innovation projects. The main activities include the administration of national and international applied research, experimental (technological) development and innovation programs, and the competitive financing of the projects related to these programs. Most of the programs during the investment period 2014-2020 are focusing on R&D infrastructure and commercialization of R&D results, but two of them directly promote technology transfer: *Innovative Checks* and *Intelektas LT (mita.lrv.lt/en*). These programs help to reduce costs incurred by the business in their cooperation with universities, i.e. purchasing R&D services.

Furthermore, **in Lithuania there is quite a number of organizations consulting on innovational development**. One of them is *Enterprise Lithuania (lt. Versli Lietuva)*. Through the provision of training, consulting and business partner search services its function is to help develop and grow competitive businesses in Lithuania. *Invest in Lithuania* is one more such kind of organization which performs the function of improving the investment environment: it seeks to develop the

infrastructure and business support services, provides consultations as well as recommendations on issues related to the labor code, education and other areas affecting country's investment environment (www.enterpriselithuania.com/en/).

However, so far these and other (mainly coming from the governmental bodies) initiatives have not created the visible value. **Low level of innovativeness in Lithuania** by **Global Innovation Index according to which Innovation Efficiency Ratio of Lithuania is ranked 84th out of 127** and scored only 0,6 out of 100. **Even though, according to the newest results of European Innovation Scoreboard 2017, Lithuania struck up from the 24th place to 16th among 28 EU countries (see Figure 2), it still remains to be called only a Moderate Innovator**. According to Skeberdytė (2016), there is a widespread public discussion going on about improving the efficiency of organizing the activities of the organizations responsible for managing innovation processes in Lithuania, because the lack of coordination of them results in a large fragmentation of instruments, programs, institutions and infrastructures. The purpose of these organizations should be to facilitate the process of innovation development rather than to create bureaucratic boundaries. As a result, the fragmentation should be reduced by combining individual small derivatives.

Figure 2. EU member states' innovation performance

(based on European Innovation Scoreboard 2017)

Such kind of fragmentation also reflects in the cooperation between academia and industry. According to the report prepared by the European Commission on Research and Innovation Performance (2017), **in Lithuania R&D intensity is steadily increasing, driven mainly by the public expenditure, but business investment in R&D remains low which causes one of the key challenges - low knowledge transfe**r. It is concluded in the report that a lack of solid science-business cooperation hampers knowledge transfer. Related to this conclusion, statistics reveal that **enterprises spend much more money on internal R&D operations than on external**, i.e. working with universities (see Figure 3). Financing for the acquisition of external knowledge also is not increasing, but the opposite. It indicates that **there is no dissemination of knowledge as well as there is no aim to acquire new learnings and to utilize the R&D activities efficiently**.

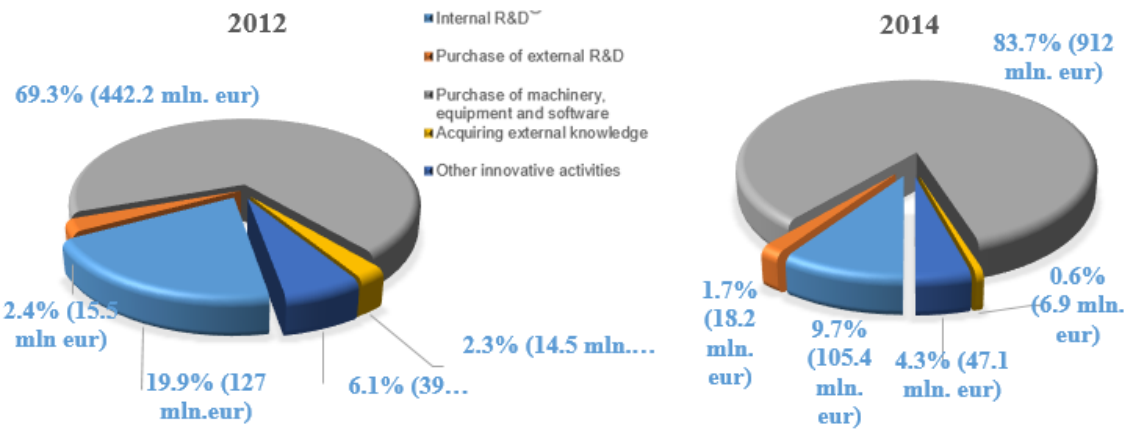

Figure 3. Innovation activity costs by objectives in the sectors of advanced and medium-high technology manufacturing, % (Lithuanian Statistics)

To add, according to Statistics Lithuania, during the period of 2012-2014 the innovation activities were performed by 40,7 % of enterprises in Lithuania. In the high-tech manufacturing sector innovations were implemented by 78,3 % of the companies while in the medium-high tech manufacturing sector - by 59,8 %. In the period of 2012-2014 the turnover of innovative enterprises accounted more than half of the total turnover of all enterprises. Expenditures for the innovative activities increased by 70,7 % and composed 1 089,3 million EUR in 2014, while it was 638,3 million EUR in 2012. However, the innovative technology companies in the high tech sector allocated 15,8 million EUR for the innovative activities, while in 2012 - 18,6 million EUR on average, and advanced technology companies - 34 million EUR, while in 2012 - 64,6 million EUR. For the purchase of external R&D contracts in 2012 it was allocated 15,5 million EUR, and in 2014 - 18,2 million EUR. In 2012 the external knowledge was acquired using 14,5 million EUR, while in 2014 - 6,9 million EUR. Meanwhile, for the internal R&D contracts it was allocated 127,7 million EUR in 2012, and in 2014 it decreased to 105,4 million EUR.

Thus, **it is a fact that the investments to innovation-related services are reducing**. Moreover, **the statistics reveal that the majority of R&D funds are allocated for the acquisition of tangible assets**: total costs increased but tangible assets represent an increasing share of 69 % in 2010, and already 84 % in 2014. Thus, material assets are increasing but there is no competence to target it and use it to the maximum. This suggests that there is a saturation of the R&D work on the local market, i.e. the point at which the cost of innovation for outsourcing does not increase, while surplus funds are invested in production equipment.

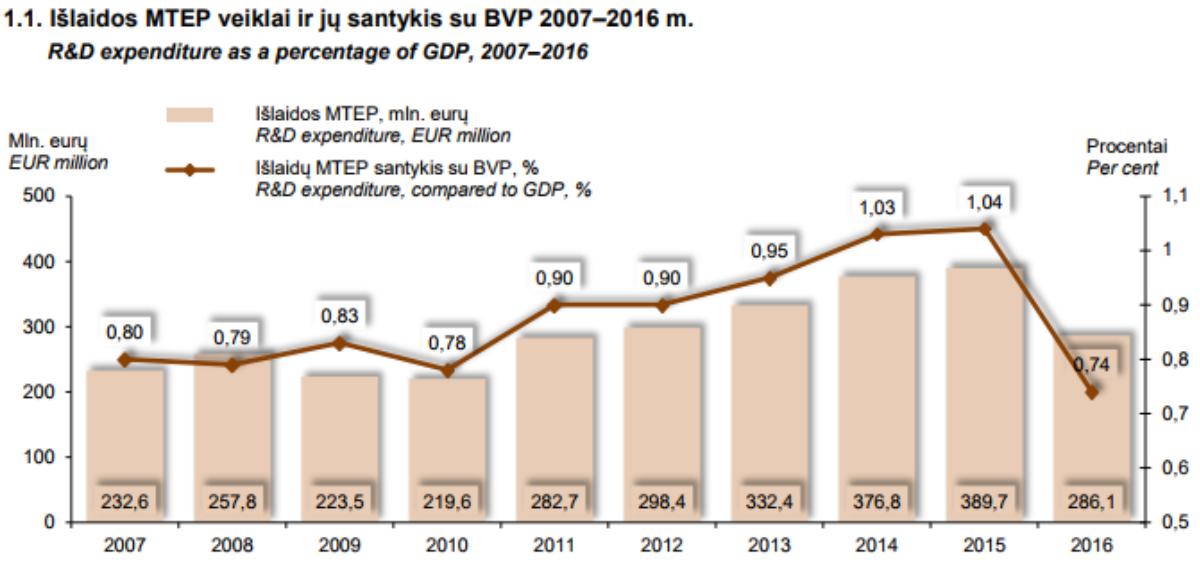

Figure 4. R&D expenditures as a percentage of GDP, 2007-2016

(Statistics Lithuania, 2017)

The decreasing expenditures on R&D (see Figure 4) in business sector can be caused by several reasons. Firstly, according to the survey provided by *Sprinter Research* (2017)**, only 55 % of owners of Lithuanian SMEs know what Industry 4.0 means and even 76 % of them admit that they are not preparing for it**. This percent unveil the **lack of understanding of current trends among the representatives of business** and the necessity of innovative approach for handling challenges of nowadays. Secondly, **the direct financial dependency on EU grants influences reduction of business expenditures on R&D**. Such conclusion is confirmed in the Review on the status of Lithuanian science and studies prepared by Research and Higher Education Monitoring and Analysis Center (MOSTA). It is notified there that in 2013 and 2014 **foreign funds were the main source of funding for R&D in Lithuania**. The largest part of these funds is consisting of the EU funds. For example, in 2014 these funds amounted to 81,7 % of all foreign funds. Despite that, **Lithuania is ranked very low, for instance, in budget share of the program Horizon 2020 country participation (27th out of 28)**.

To continue, reduced expenditures on R&D confirms the low efficiency of academia-industry cooperation. In order to find out the reasons for that and to propose recommendations for improving of such situation, MOSTA conducted a survey. 1086 researchers residing in institutions of higher education (universities and research institutes) and 223 business executives who work in enterprises which carry out R&D activities with other companies and/or public sector were surveyed. In Lithuania it was the first survey of such nature and scale. Results revealed that **researchers who have previously worked in the private sector and companies with managers who have worked in a science sector or gained doctoral degree have more willingness for cross-sectoral collaboration**. Thus, it is assumed that **connections play an important role in initiating joint R&D activities**. The research also revealed that **most of R&D projects are engaged through personal relations, and agencies that need to foster scientific and business collaboration do not perform this function well**. According to the data, just few percents of the representatives indicated that they were included in R&D projects regarding cross-sectoral collaboration by organizations supporting innovation, such as *Lithuanian Innovation Center (LIC), Enterprise Lithuania* and *Invest in Lithuania*. Moreover, **in the process of collaboration with science business enterprises are often hampered by complex project management and the lack of financial resources needed to develop R&D activities**. Complex management of joint R&D projects and complicated and slow process at science and study institutions in arranging contracts were mentioned as the reasons for low level of academia-industry cooperation by no less than a third of respondents representing enterprises. Nevertheless, a major obstacle to collaborate with science, according to business, is the lack of information which is not accurately communicated. This reason was pointed out by seven out of ten business representatives. Therefore, **the results of this survey indicates deficiency of effective work of technology transfer offices in Lithuania**.

To sum up, as for today there is a lack of common effort to face the challenges in an effective and prosperous way in Lithuania. Industry is operating separately from science. This creates the gap in the economic and social welfare because the novel knowledge created in academic institutions is vaguely used in practice. TTOs are created as the tools to assist this matter, however, in Lithuanian context they are barely managing this function. Moreover, although we have science parks, there are no management practices developed which would produce effective results, as well as there is a lack of knowledge of what factors affect performance and how to manage them. In general, there are no successful performance measurement systems implemented in Lithuanian TTOs from which it would be possible to learn. Thus, in order to bridge this gap, factors influencing the performance of TTOs as well as their reasoning need to be investigated.

2. THEORETICAL AND PRACTICAL RESEARCH PRESUMPTIONS OF THE FACTORS INFLUENCING THE PERFORMANCE OF THE TECHNOLOGY TRANSFER OFFICES

This chapter covers theoretical and practical research presumptions of the factors influencing the performance of TTOs. It ***consists of three sub-chapters:***

1) In the first one the following topics are discussed: channels and forms of interaction for technology transfer; stakeholders involved in knowledge transfer process; Bayh-Dole Act and the establishment of TTOs; definition of TTO; consistent explanation of technology transfer process; possible outcomes of commercialized researches.

2) The second sub-chapter is about monetary and non-monetary key performance indicators and their value in assessing the performance of TTOs.

3) The last sub-chapter covers the following issues: literature review on studies related to the performance of TTOs; description of the factors influencing the performance of TTOs distinguished in the literature and their classification according to the subject; and an overview of the literature based on the context in which the performance of TTOs is being investigated.

2.1. Performance of the Technology Transfer Offices

From the academic perspective related to science, technology and innovation it is widely recognized that the individual players (such as companies, universities, government research laboratories, etc.) are not able to fulfil the innovative capacity of the nation on their own but rather need to link their strengths (Weckowska, 2014). In order to achieve synergy which stimulates economic growth, industry and universities need fruitful collaboration. The latter can be designed by exploiting resources from the both sides, meaning, commercializing technologies resulting from scientific research. Such linking process is known as knowledge (or technology) transfer.

As nowadays knowledge transfer is crucial for the economic development, the **diversity of potential channels, through which technology transfer is processed**, is present. For instance, even ten such kind of categories were distinguished by Brennenraedts et al. (2006) using which the knowledge can be transferred between universities and companies: i) publications; ii) participation in conference professional networks and boards; iii) mobility of people; iv) other informal contacts/networks; v) cooperation in R&D; vi) sharing of facilities; vii) cooperation in education; viii) contract research and advisement; ix) intellectual property rights, x) spin-offs and entrepreneurship (Ustundag et al., 2010). Meanwhile **Skeberdyte (2015) systematized forms of interaction between academia and industry**

to five groups: i) *scientific activity*; ii) *dissemination*; iii) *mobility*; iv) *academic activity*; v) *entrepreneurship* (see Table 1).

Table 1. Forms of interaction between science and business organizations by type activity (Based on Skeberdyte, 2015)

Type of activity	Forms of interaction
Scientific activity	• Co-authoring for scientific publications • Joint research activities • R&D contracts initiated by business • Provision of expert advice • Joint, national, international projects, programs • Consultation for the business sector • Expert evaluation of projects
Dissemination	• Presenting a report at a scientific conference, participating in scientific events • Membership in collegial organizations which are considering R&D questions • Use of scientific infrastructure in other organizations • Activities on various innovation platforms (incubators, science parks, etc.) • Participation in social networking platforms
Mobility	• Employment of doctoral students • Position in the science and business organization • Employing foreign researchers • Visits of foreign scholars • Internship abroad
Academic activity	• Teaching at a high school • Organizing scientific seminars • Supervising doctoral students • Member of the commission for the defense of PhD Theses
Entrepreneurship	• Establishment of a spin-off company • Commercialization of knowledge, technology or other applied research • Direct scientific work with industry in developing new, improved products, services, processes • Presentation of research opportunities for the business sector • Purchase of equipment • Business project with the business sector

Knowledge transfer process has not only many shapes but also involves parties, so-called ***stakeholders***, such as *academic researchers*, who discover novel technologies, *technology transfer offices*, which serve as intermediates between university scientists and companies and manage university's IP, and *private industry*, which commercialize university-based inventions (Anderson et al., 2007; Siegel et al., 2003b). They all have certain motives to participate in technology transfer process (see Table 2). **TTO is assumed to be the main stakeholder** among the mention ones as it is a formal mechanism which is created in order to transfer research based novelty from the universities to the business sector for mercantile application and social advantage (Ustundag et al., 2010).

Table 2. Key stakeholders in technology transfer process

(based on Siegel et. al., 2004, and Bersenaite, 2016)

Stakeholder	Actions	Motive(s)	Perspective
University scientist	Discovery of new knowledge	• Recognition within the scientific community - publications, grants (especially if untenured); • Learning (getting information and feedback from business, getting to know about partner issues, ongoing research, adapting the results of their research, becoming part of the network); • Financial gain and a desire to secure additional research funding (mainly for graduate students and lab equipment).	Scientific
TTO	Works with faculty members and firms/entrepreneurs to structure deals	• Protect and market the university's IP; • Facilitate technological diffusion and secure additional research funding.	Bureaucratic
Firm/ entrepreneur	Commercializes new technology	• Financial gain; • Maintain control of proprietary technologies; • Access and use of academic networks; • Strengthen its position in the market.	Organic/ entrepreneurial

The establishment of TTOs in many academic institutions is the result of the University and Small Business Patent Procedures Act, commonly known as the **Bayh-Dole Act** (Siegel et al., 2003b), which was enacted by the **U.S. Congress** in 1980 and took effect on July 1st in **1981** (Carlsson & Fridh, 2002). This Act enabled universities to prospect their knowledge transfer on a broader scale as it simplified this process by initiating an equal patent policy and eliminating many limitations on licensing (Siegel et al., 2003b). Before the Bayh-Dole, funding agencies which provided federal grants for the U.S. universities owned the rights to intellectual property. As because of this reason the options for licensing were restricted, not many academic institutions were willing to get involved into the process of patenting. The initiators of the Bayh-Dole Act argued the benefit for the taxpayers of such document, as the results of publicly funded scientific researches are supposed to have a possibility to be developed further and at some point - commercialized (Carlsson & Fridh, 2002). Therefore, starting in the U.S., the concept of TTO did not take long to spread around the world, and especially - in Europe.

It is important to note that the relations between industry and science also existed before the establishment of TTO (see Figure 5). Naturally, the establishment of the department, which is directly

responsible for such relations, created new, previously not existing contacts but the existing links between university researchers and business representatives persisted (see Figure 5).

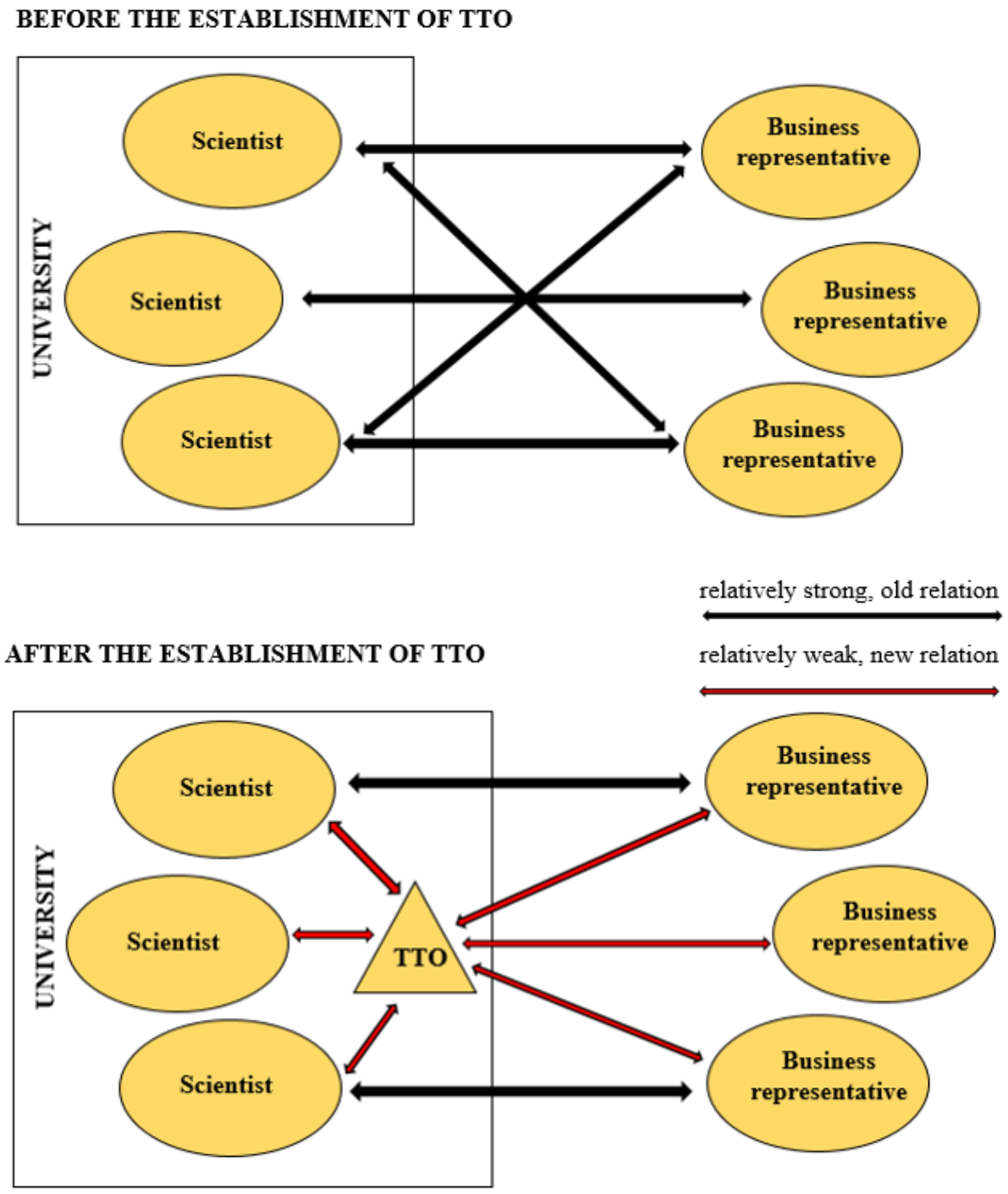

Figure 5. The dynamics of university-industry relations before and after the establishment of TTO (based on Hulsbeck, 2013; Hsiu-Ching et al., 2013; and Jonsson et al., 2015)

Since the foundation of TTO, the functions of it were gradually broadening: from primarily being responsible only for licensing the scientific inventions to business to turning them into marketable products (see Table 3). As Weckowska (2014) names it, **there are five key roles supposed to be**

performed by each TTO: i) encouraging disclosure of potentially commercializable inventions; ii) managing the university's intellectual property; iii) identifying licensees and/or investors; iv) securing resources for IP development and exploitation; v) intermediating among scientists, firms and university administrators. Generalizing these features, **the following definition of TTO is suggested**: *By recognizing potentially commercializable inventions and identifying licensees and/or investors for them, the **Technology Transfer Office** is an intermediary between academia and industry, ensuring resources for the development and exploitation of university's intellectual property*.

Table 3. Definitions of Technology Transfer Office

(Source: composed by the authors)

No	Definition of Technology Transfer Office (TTO)	Scholar(s)	Year
1	As the Bayh-Dole Act puts it, "the mission of university technology transfer offices is to transfer research results to commercial application for public use and benefit. <…> The major effort of the office is to find companies which have the capability, interest and resources to develop embryonic technologies into useful products" (The Council on Governmental Relations, 1993, p. 2).	Carlsson B., Frith A.	2002
2	TTOs facilitate technological diffusion through the licensing to industry of inventions or intellectual property resulting from university research.	Siegel D. S., Waldman D., Link A.	2003
3	The primary role of a TTO is to manage and perform technology transfer activities (AUTM, 2004)	Anderson T. R., Daim T. U., Lavoie F. F.	2007
4	The technology transfer offices (TTOs) facilitate commercial knowledge transfers through the licensing to industry of inventions or other forms of intellectual property resulting from university research. These offices also conduct activities of supporting spin-offs, negotiating industry sponsored research agreements and consulting.	Ustundag A., Ugurlu S., Kilinc M. S.	2011
5	A TTO can be considered as a process catalyst, a knowledge converter and an impact amplifier.	Tahvanainen A. J. Hermans R.	2011
6	...translating basic technology advances into commercial innovations is a central feature of a knowledge-based economy - and technology-transfer offices (TTOs) are central agents in managing publicly funded academic inventions into commercially valuable product innovations.	York A. S.	2012
7	TTOs solve problems by encouraging and coordinating cooperative research with industry, provide access to specialized instrumentation and equipment, incubate services and provide assistance with cooperation agreements (Rothaermel et al. 2007). They are also engaged in providing public outreach by forming and assessing networks, stimulating social interaction and influencing the direction of search processes among users and suppliers of technology and fundamental researchers.	Hulsbeck M., Lehmann E. E., Starnecker A.	2013

8	<...> the abilities required for five key aspects of TTO role: - encouraging disclosure of potentially commercializable inventions; - managing the university's Intellectual Property; - identifying licensees and/or investors; - securing resources for IP development and exploitation; - intermediating among scientists, firms, and university administrators.	Weckowska D. M.	2014
9	These offices facilitate the process of commercial knowledge transfer from university to industry (Siegel et al. 2007). TTOs are primarily responsible for the protection of university created IP, and the management of the commercialization process (Markman et al. 2005).	Vinig T., Lips D.	2015

In order to have a perception of the technology transfer process, it is essential to know how it is carried out. Typical process of technology transfer concluded by licensing agreement or start-up (which should be called spin-off regarding the terminology used in this study) is illustrated by Tseng and Raudensky (2014) (see Figure 6). The first five steps are marked in green and belongs to the patenting. The remaining five steps marked in white are reflecting the licensing process. The major actors of technology transfer process associated with each step - university scientist, TTO and firm/entrepreneur - are also indicated. Red-colored decision illustrated in the figure represents the termination of the patenting process. Proposals are usually given for reconsideration. However, before describing, it is crucial to mention that *this linear illustration is not necessarily applicable for all processes of technology transfer at actual situations because the latter are influenced by many factors and some of them cannot even be foreseen*.

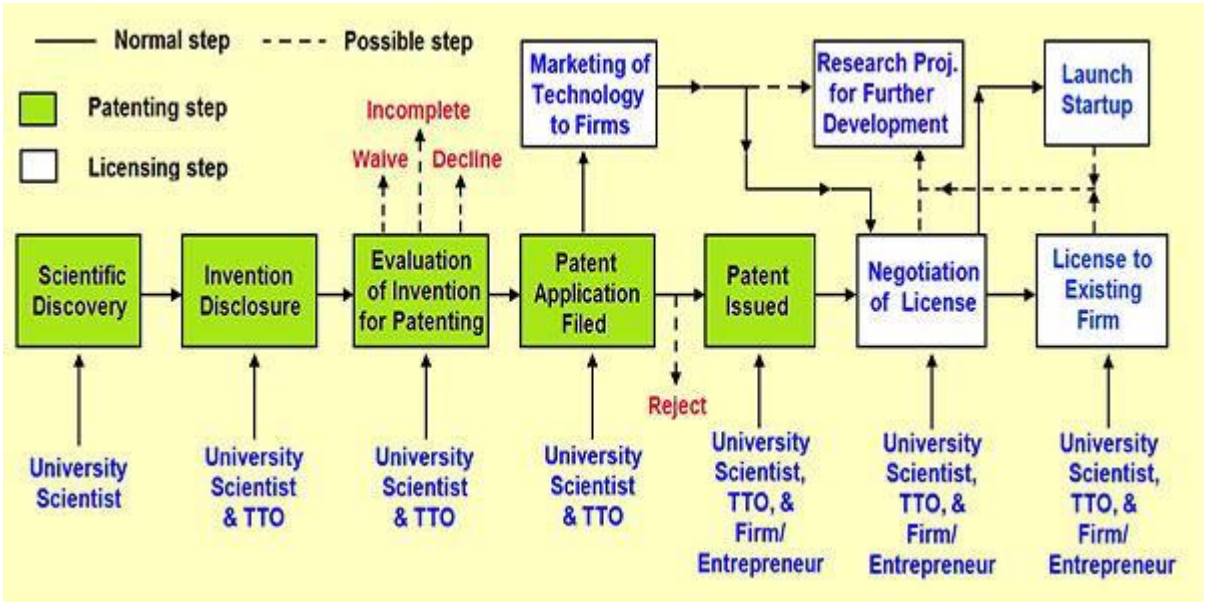

Figure 6. Typical process of technology transfer in the universities

(Tseng & Raudensky, 2014)

The first step of **technology transfer process** is scientific discovery. Once the latter is done, the scientists are obliged to file an invention disclosure which needs to be sent to TTO. According to the research done by Siegel et al. (2003a), this rule is rarely applied, therefore, the employees of TTO should dedicate more effort in encouraging scientists to disclose inventions. After the formal disclosure of invention, the duty of TTO is to evaluate the potential for the commercialization of the technology. Then a decision on patenting must be made. If there is already an interest from the company to purchase the technology, TTO has sufficient grounds to initiate filing a patent. In other cases, TTO has to be expert enough to make such judgement before industry shows an interest in the invention. Besides that, the decision regarding the scale of patent protection must be made as well. Domestic patent protection is significantly cheaper, however, it also has less value to potential licensees. The dilemma between domestic and global patent protection is always present because of the financial situation of TTOs.

If the decision is made to file the patent application and patent is awarded, the attempt of TTO is to commercialize the invention. This process cannot be carried out without marketing. Scientists and research groups working with them are usually involved in this phase because they are often able to distinguish potential licensees. Moreover, **the technical expertise is often the main reason why the scientists become a natural partner for enterprises which are willing to commercialize the technology**. However, it is proved by Jensen and Thursby (2001) that **in many cases the companies are licensing a technology even before it is patented**.

The negotiation of **licensing agreement** with companies or individual entrepreneurs is the final step of university-industry technology transfer process. **The university can benefit from such agreements by receiving royalties, continuous financed research agreements or an equity share in a newly established venture which is based on the patented technology.** Despite the obvious possible financial benefits, Siegel et al. (2003a) discovered that many public universities are still reactive to the fact that they are giving away the technologies which are university-based and taxpayers-funded. As a result of this attitude, many technology transfer offices are setting up difficult conditions for negotiating licensing.

To continue, TTO involvement into technology transfer process is not finalized by signing of a licensing agreement because dedicating relevant resources to the upkeep and renegotiation of licensing agreements are common practices for TTOs. This is applied both to the inchoate nature of the inventions and to the juvenile nature of multitude of enterprises which license technologies created in universities (Siegel et al., 2003a).

Licensing is one of the possible results of technology transfer process. Establishment of a new venture - a spin-off - also could be a solution for technology transfer. However, legislative system related to such foundation at the university has to be created accordingly. Overall, the number of licensing agreements and spin-offs is the most common key performance indicators for TTOs (Anderson et al.,

2007; Thursby & Thursby, 2002; Kim et al., 2008; Caldera & Debande, 2010; Ustundag et al., 2011; etc.), therefore, it is directly in university's interest to have required settings prepared in order to perform well on achieving goals.

2.2. Monetary and Non-monetary Key Performance Indicators

In the past few decades, technology management and innovation performance was evalued based on economic values (Vinig & Lips, 2015) also known as **monetary indicators**. For instance, by using a data envelopment approach (DEA) such scholars as Kim et al. (2008), Thursby and Kemp (2002) and Anderson et. al (2007) **indicated mostly financial capital related values, for example, general income, research expenditure, license income**. On the contrary, by using simple linear regression analysis Caldera and Debande (2010) estimated income from R&D contracts and licensing. While conducting the cross-country comparison between UK and USA TTOs Siegel et al. (2008) was using stochastic distance function method, and he also identified monetary indicators, such as total research income and external legal IP expenses. Moreover, Curi et al. (2012) conducted study about French TTOs and distinguished one more financially-related variable - regional R&D intensity. According to the scholars (Chapple et al., 2005; Siegel et al., 2003; Siegel et al. 2008), **TTOs established in regions with higher R&D activity are generating more income**. Furthermore, **regional GDP per capita affects the growth of license income as well**.

However, **the calculation of revenues from patents, equity positions in spin-offs and license agreements does not reveal the overall performance of TTOs. Measures based on the revenues do not evaluate the potential behind the agreements and patents that exist and are about to be brought out to the market.** Authors Vinig and Lips (2015) emphasized that **such non-monetary indicators as number of patents, licenses and spin-offs can also provide relevant information on the performance of TTOs.** For instance, the number of academic publications indicates the possibility of novel knowledge which could generate revenues if was developed into a commercialized product or service. Another potential indicator is a number of patent applications which is used to measure the performance by the following authors: Siegel et al. (2007), Secundo & Ellia (2014), Kim et al. (2008). However, this output can change in time and is not very precise because the patent application form can be rejected and patent - not awarded (Baldini, 2006). Moreover, the number of license agreements is one more indicator which shows the potential of monetization because of the existing relations with industries (Chapple et al., 2005; Siegel et al., 2005; Caldera & Debande, 2010).

Table 4. Monetary and non-monetary key performance indicators

(Composed by the authors)

Scholar	Year	Monetary and Non-monetary KPIs
Lee	2000	- Equity sales; - Equity holdings.
Thursby & Thursby	2002	-Invention disclosures, -Patent applications, -License and option agreements
Chapple et al.	2005	- Output: number of licences or licencing income - Invention disclosures - Total research income - External legal IP expenditure - Regional GDP - Regional R&D intensity
Siegel et al.	2005	-Number of spin-offs -Number of licenses -Licensing income -Total research income -External legal IP expenses -Proportion of research income from business -GDP per capita -R&D as a % of GDP
Anderson et al.	2007	-Total sponsored research in dollars; -License income and invention disclosures; -Start up companies, -Patents filled, -Patent issued.
Siegel et al.	2007	-Patents -Licensing
Kim et al.	2008	-Research expenditure -Income -Licenses executed -Start ups -Patents filled -Patents issued
Caldera & Debande	2010	-R&D contracts, -Licensing, -Number of R&D contracts, -Licensing agreements, -Number of spin-off
Ustundag, Ugurlu & Kilinc	2011	- Number of patents awarded; - License income; - Number of established spin-offs.

Curi, Daraio & Llerena	2012	-Public and Private R&D Expenditure, -GDP per capita as index of regional development, -Growth public/private R&D intensity which is the rate of public/private investments in R&D

According to the information provided in Table 4 and synthesized literature analysis, it can be observed that in order to assess the performance of TTOs while conducting their researches the scholars mostly **distinguished such monetary and non-monetary KIPs as license agreements**, **licensing income**, **number of spin-offs**, **startups** and **R&D contracts**, **filed patents** and **invention disclosures**. **However, these metrics measure the results of the performance of TTOs, and thus, only identify at what level TTOs are performing. However, they do not reveal how TTOs should upgrade their activities in order to improve their performance. Therefore, it is accepted that TTOs are influenced by the external factors**, such as political and economic uncertainty, **as well as the internal ones**, such as IP regulations and policy, human capital or strategy of TTO, **which influence the performance**. For instance, a clear strategy of the university should be created and communicated in order to enable scientists and TTOs for more efficient cooperation. Additionally, if a decision to manage licensing portfolio is made, training and development of TTO personnel should be provided accordingly (Chapple et al., 2005). **Moreover, factors are getting more relevant in the value creation process of TTOs. Thus, it is crucial to explore the main factors influencing the performance of TTOs as well as to identify the reasoning for them.**

2.3. Selected Review of the Literature on the Performance of Technology Transfer Offices

The debate around the topic related to the **performance of TTOs** has remained present among the stakeholders of technology transfer process since the first studies made by Thursby and Thursby (2002) as well as by Thursby and Kemp (2002). Even though the interest from policymakers on this topic is increasing and a number of initiatives are documented on a political level, **in the literature this issue is investigated deficiently, especially in the European context** (Curi et al., 2012).

Number of findings in the literature on the performance of TTOs were done using different methodological approaches (see Table 5). For instance, by using linear regression method Foltz et al. (2000) found out that university patenting is influenced positively by faculty quality, state research funding and number of TTO employees. Meanwhile Carlsson & Fridh (2002) used the same methodological approach for their research and discovered that age of TTO, research expenditure and number of invention disclosures affect positively on patenting and licensing at universities. Following the same methodological direction, more recent study was conducted by Caldera and Debande (2010). Besides other, such conclusions as i) more spin-offs are generated if the researchers are allowed to take

a leave for the purpose to establish a new venture, and ii) licensing income is affected by royalty sharing policy were made. On the other hand, DEA as a method to conduct research on the performance of TTOs was also used by a number of scholars. For example, complementing to Foltz et al. (2000) work, in their study Thursby and Kemp (2002) revealed that a variety of technology transfer outputs are influenced positively by faculty quality and number of TTO personnel. They also claim that public universities are not as productive as private ones and that having a medical school impacts the efficiency of universities negatively. Contradicting findings to the latter ones were revealed by Anderson et al. (2007). These scholars claim that it is not sufficient to identify the ownership of university (private versus public) and the existence of a medical school in order to interpret the variation in knowledge transfer efficiencies. Supplementary features should be studied: the number of TTO staff, incentive systems at faculty and the influence of various IP policies.

Table 5. Findings on the performance of TTOs

(based on Siegel et. al., 2007)

Scholar(s)	Methodology	Key results
Rogers et al. (2000)	Correlation analysis of composite technology-transfer score	Positive correlation between faculty quality, age of TTO, and number of TTO staff and higher levels of performance in technology transfer.
Foltz et al. (2000)	Linear regression	Faculty quality, federal research funding, and number of TTO staff have a positive impact on university patenting.
Thursby et al. (2001)	Descriptive analysis of authors' survey/regression analysis	Inventions tend to be disclosed at an early stage of development; elasticities of licenses and royalties with respect to invention disclosures are both less than one; faculty members are increasingly likely to disclose inventions.
Bercovitz et al. (2001)	Qualitative and quantitative analysis	Analysis of different organization structures for technology transfer at Duke, Johns Hopkins, and Penn State; differences in structure may be related to technology transfer performance.
Thursby & Kemp (2002)	DEA and logit regressions on efficiency scores	Faculty quality and number of TTO staff have a positive impact on various technology-transfer outputs; private universities appear to be more efficient than public universities; universities with medical schools are less efficient.
Thursby & Thursby (2002)	DEA	Growth in university licensing and patenting can be attributed to an increase in the willingness of professors to patent and license, as well as outsourcing of R&D by firms, not to a shift towards more applied research.
Carlsson & Fridh (2002)	Linear regression	Research expenditure, invention disclosures, and age of TTO have a positive impact on university patenting and licensing.

Friedman & Silberman (2003)	Regression analysis — systems equations estimation	Higher royalty shares for faculty members are associated with greater licensing income.
Siegel et al. (2003a)	TFP of university licensing — stochastic frontier analysis and field interviews	TTOs exhibit constant returns to scale with respect to the number of licenses; increasing returns to scale with respect to licensing revenue; organizational and environmental factors have considerable explanatory power.
Lach & Schankerman (2004)	Regression analysis	Higher royalty shares for faculty members are associated with greater licensing income.
Chapple et al. (2005)	DEA and stochastic frontier analysis	UK TTOs exhibit decreasing returns to scale and low levels of absolute efficiency; organizational and environmental factors have considerable explanatory power.
Link & Siegel (2005)	TFP of university licensing — stochastic frontier analysis	Land grant universities are more efficient in technology transfer; higher royalty shares for faculty members are associated with greater licensing income.
Anderson, Daim & Lavoie (2007)	DEA	Simple explanations such as public versus private and the presence of a medical school do not explain the variation in technology transfer efficiencies. Additional characteristics should be examined: the number of people working in TTO, the impact of different intellectual property policies, and faculty incentive systems.
Caldera & Debande (2010)	Linear regression analysis	Internal technology transfer policies and the nature and type of technology transfer intermediaries are important factors influencing the performance of universities. Royalty sharing policy affects licensing income. Allowing scientists to take a leave to create a firm generate more spin-offs. Science park has a positive effect on the commercialization of university research. TTO size has a positive effect on R&D contract activity, licenses, spin-offs created, but does not affect licensing income. TTO experience affects only R&D contract activity. TTO specialization influence only the number of R&D contracts generated, but not other outcomes.
Hulsbeck, Lehmann & Starnecker (2013)	Regression analysis	Neither the size of TTO nor the percentage of academics shapes the number of invention disclosures, but the division of labor does. The existence of TTO has little economic value. Most universities lack "entrepreneurial spirit" to proactively foster technology transfer. Both experience and an early commitment to an orientation of an academic entrepreneurship strategy significantly shape TTO performance.
Ustundag, Ugurlu & Kilinc (2011)	FCM	TTO human resources, industry research demand, R&D budget of university and economic uncertainty are the most influential factors on the performance of TTOs. The performance outputs which are mostly affected are the factors, licenses, patents, established spin-offs, industry research contracts and consulting income.

York & Ahn (2012)	Deductive (literature review) and inductive (semi-structured interviews) methods	Major success factors: business strategy and marketing, intellectual property protection, performance benchmarking, revenue generation focus, institutional prestige, business stakeholder relationships, alignment of institutional interests, and institutional support.
Curi, Daraio & Llerena (2012)	DEA	TTOs efficiency depends extensively on the nature of the category, institutional and environmental characteristics. Positive effect has age of TTO, size of the university, the intensity of R&D activity (both private and public) and the presence of a university-related hospital.
Fini et al. (2017)	Multilevel negative binomial regression	Changes in the institutional framework conditions at both national and university levels are conductive to the creation of more spin-offs, but the increase in quantity is at the expense of the quality of these firms.

Different perspectives regarding the factors influencing the performance of TTOs have been analyzed so far. For instance, Markman et al. (2005) developed a model to identify the links between TTO structures, new venture information and licensing strategies. It was identified that shorter time of commercialization process can positively influence the performance of TTO, and that expertise of the personnel has positive impact in assessing licensing process professionally. Meanwhile other scholars (Friedman & Silberman, 2003; Caldera & Debande, 2010) focused on a clear mission and objectives, location and organizational structure of TTO. Academics Santoro and Gopalakrishnan (2000) found out that companies with more mechanistic structure, stability oriented culture and trust in universities as partners are more likely to establish knowledge transfer activities. The authors also indicated that trust is the main variable for evaluation of knowledge transfer activities. Knowledge creation requires new ideas which have to be integrated, combined with existing knowledge and seen from a new perspective while crossing organizational borders. Furthermore, appropriate culture of an organization enables to facilitate the external knowledge for improving quality and quantity of task-related activities. York and Ahn (2012) supplemented the latter conclusion by systematically comparing successful and less successful TTOs in order to indicate the factors which lead to the success of technology transfer offices owned by universities. During the conduction of empirical research, they compared their cases through the following identified dimensions: i) age and size; ii) business strategy/marketing; iii) intellectual property protection; iv) performance benchmarking; v) revenue generation focus; vi) business stakeholder relationships; vii) institutional support; viii) project structure; and ix) internal and external website utility. Meanwhile empirical quantitative and qualitative research conducted by Siegel et al. (2003a) revealed a set of groups of internal, environmental and institutional, organizational factors that influence the performance of TTOs. According to authors, it was identified that the most important factors are the following: i) reward system at the faculty; ii) compensation on staff practise; iii) TTO's ability to destroy cultural barriers between universities and business. To continue, in their study

Frederick and Granieri (2016) tried to validate the business growth CCODE[1] model and based on it identified 28 influential factors. The review conducted by these scholars highlighted a number of new factors influencing the performance of TTOs: i) tools and methodologies; ii) customer base scale and absorptive capacity; iii) IP quality, security and market relevance; iv) knowledge generation capacity; v) TTO desire, IP creator desire; vi) proximity to market.

Even though there is a significant number of studies conducted on factors influencing the performance of TTOs, **so far they have been discussed in a fragmentary way and differed from research to research depending on the subject angle. Also there has been no clear distinction which of them are suitable for the European context. Furthermore, no study to date has classified them according to subject similarity. Based on this gap in the literature, six groups of factors were distinguished** (see Table 6): i) **IP strategy and policy**; ii) **organizational design and structure**; iii) **human capital**; iv) **industry links**; v) **economic incentives**; vi) **cultural aspects**. The factors classified for the group *IP strategy and policy* concentrate on the matters related to intellectual property rights and their management as well as on support for TTO provided by the university on a strategic level. The group of factors *Organizational design and structure* is about composition of TTOs. They are structured in different models as well as they differ in size, age, experience, etc., and studies reveal that these factors have a significant impact on the performance of TTOs. The latter group of factors is closely related to the one focused on *Human capital* because it depends what kind of background and expertise is required for the personnel of TTO, what conditions are created for improving qualification, how long it takes in order to achieve positive results, etc. Thus, group of factors *Human capital* concentrates on these issues. Factors' group *Industry links* represents the awareness of industry needs and the importance of networking through interactions between scientists and companies. Meanwhile the group *Economic incentives* is about the financial situation and internal/external support for TTOs as well as for the actors in the relevant innovation ecosystem. The last group of factors - *Cultural aspects* - includes mindset concept of the different actors involved into technology transfer process.

[1] CCODE- is a tool developed by Pera Consulting, which states that all organisations pass through a series of stages in their development.

Table 6. Factors influencing the performance of TTOs classified into six groups of factors

(Concluded by the authors)

Scholars	Groups of Factors	Factors
Caldera A. & Debande O. (2010); Siegel D. S., Waldman D., Link A (2003); Lach S. & Schankerman M. (2004); Debackere K. & Veugelers R. (2005); Santoro M. D. & Bierly P. E. (2006)	**IP strategy and policy**	-University policies; -Bureaucracy; -The impact of rewards for faculty involvement in technology transfer; -Clear mission and objectives; -University technology transfer - intellectual property policies.
Anderson T. R., Daim T. U., Lavoie F. F. (2007); Friedman J. & Silberman J. (2003), Siegel, D.S., Waldman, D., & Link, A. (2003a); Secundo G., de Beer C., Passiante G. (2016); Carlsson B. & Frith A. (2002); Thursby J. G., Jensen R., Thursby M. C. (2001); Curi C., Daraio C., Llerena P. (2012)	**Organizational design and structure**	-Public versus private; -Presence of a medical school; -Organizational structure and operational processes/policies of TTO; -The level of authority and support given to TTO in the university administration; -University organizational forms; -Participation of faculty in the licensing process; -The experience of TTO; -The presence of a science park; -The size of TTO.
Markman G. D., Gianiodis P. T., Phan P. H., Balkin D. B (2005); Chapple W., Lockett A., Siegel D., Wright M. (2005); Libecap G. (2005); Kim J., Anderson T., Daim T. (2008)	**Human capital**	-TTO competency in identifying licenses; -TTO staffing/compensation practices; -A balanced skill-set of managers, scientists and lawyers within TTO personnel; -Business skills and management capabilities at TTO.
Tahvanainen A.J. & Hermans R (2011); Hulsbeck M., Lehmann E. E., Starnecker A. (2013) Perez M. & Sanchez A. M. (2003); Libecap G. (2005); Frederick & Granieri (2015); York A. S. & Ahn M. J. (2012);Santoro M. D., Bierly P. E. (2006)	**Industry links**	-The amalgamation of solid technical expertise and extensive industrial experience in the individual licensing officer; -TTO understands the needs of industry; -The influence of innovation networks on the dynamics of the technology transfer; -Social connectedness and trust between industrial firms and university research centers.
Ustundag A., Ugurlu S., Kilinc M. S. (2011); Anderson T. R., Daim T. U., Lavoie F. F. (2007); Chapple W., Lockett A., Siegel D., Wright M. (2005); Curi C., Daraio C., Llerena P. (2012); Frederick P. & Granieri M. (2015); York A. S. & Ahn M. J. (2012); Foltz J., Barham B., Kim K. (2000)	**Economic incentives**	-Regional concentrations of venture capital and high technology; -The regional economic status; -The level of priority and support given to higher education in a community or region; -Location of TTO on performance; -GDP per capita; -Industrial agglomeration; -Private spending on R&D; -Government support.

Siegel et. al (2003); Siegel et. al. (2004); Jasinski (2009); Harman (2010); York & Ahn (2012); Campbell (2007); Plewa et al. (2006).	**Cultural aspects**	-Cultural barriers between universities and firms; -Cultural differences between the academic and the commercial domains; -R&D institutions not fully open or prepared to cooperate with firms; -Innovative culture and mentality among employees; -Institutional support to scientists for involvement in technology transfer process; -Expanded institutional alignment factor.

Following the available **literature on technology (knowledge) transfer** and the performance of TTOs it is evident that so far **most of it has been concentrated exceptionally on the U.S. cas**e (Shane (2004); Thursby & Kemp (2002); Thursby & Thursby (2002); Siegel, Waldman & Link (2003), Lockett & Wright (2005); Anderson, Daim & Lavoie (2007); Kim, Anderson & Daim (2008) , Heisey and Adelman (2011), Tahvanainen & Hermans (2011), York (2012), Tseng & Raudensky (2014)), **the UK** (Lockett, Wright & Franklin (2003); Chapple et al. (2005); Meyer and Tang (2007); Siegel et al. (2008); Ismail, Omar & Majid (2011)) **and Italy** (Balderi et al. (2007); Fini, Grimaldi, and Sobrero (2009); Muscio (2010); Fini et al. (2011); Algieri, Aquino & Succurro (2013)). The concept of TTO was created in the U.S., thus it is consequential accordingly that most of the studies are conducted in this context. According to Chapple et al. (2005), TTOs in the UK could be comparable to the ones in the U.S., therefore, TTO context in this country is also analyzed quite broadly. However, other countries have also been investigated by several studies (see Table 7). For instance, studies related to Spanish and German cases were conducted by couple authors: del Barrio-Castro & García-Quevedo (2009), Caldera & Debande (2010), and Hulsbeck, Lehmann & Starnecker (2013), Buenstorf & Geissler (2012) respectively. There are also researches conducted for the other countries, such as analysis of the role of academic TTOs in improving links between science and industry in Belgium (Debackere & Veugelers, 2005); regional case study on knowledge-based typology of university spin-offs in Canada (Bathelt, Kogler & Munro, 2010); patenting at public research institutions in Denmark (Baldini, 2006); technology transfer mechanisms in Sweden (Nilsson, Rickne & Bengtsson, 2010); measuring the performance of university technology transfer in the Netherlands (Vinig & Lips, 2015), and the productivity of TTOs in France (Curi, Daraio & Llerena, 2012). And **while several empirical studies find immense reasoning for the importance and performance of TTOs based in the U.S.** (Siegel et al., 2003), **various studies on continental European countries** (Swedish example studied by Goldfarb & Henrekson, 2003; Belgian - by Saragossi and van Pottelsberghe de la Potterie, 2003; German - by Krucken et al., 2007; Italian - by Muscio, 2010) **did not provide enough evidence to confirm the presumption that TTO has positive implications on promotion of the commercialization of scientific research.**

Table 7. Existing literature classified by the context in which the performance of TTO was studied (based on Cartox & Godinho, 2017)

Context in which the performance of TTOs was studied	Scholar(s) and year
The U. S.	Shane (2004); Thursby & Kemp (2002); Thursby & Thursby (2002); Siegel, Waldman & Link (2003), Lockett & Wright (2005); Anderson, Daim & Lavoie (2007), Kim, Anderson & Daim (2008), Heisey and Adelman (2011), Tahvanainen & Hermans (2011), York (2012), Tseng & Raudensky (2014)
The UK	Lockett, Wright & Franklin (2003); Chapple et al. (2005); Meyer and Tang (2007); Siegel et al. (2008); Ismail, Omar & Majid (2011)
Italy	Balderi et al. (2007); Fini, Grimaldi, and Sobrero (2009); Muscio (2010); Fini et al. (2011); Algieri, Aquino & Succurro (2013)
Belgium	Debackere & Veugelers (2005)
Canada	Bathelt, Kogler & Munro (2010)
Denmark	Baldini (2006)
The Netherlands	Vinig & Lips (2015)
France	Curi, Daraio & Llerena (2012)
Germany	Hulsbeck, Lehmann & Starnecker (2013), Buenstorf & Geissler (2012)
Spain	del Barrio-Castro & García-Quevedo (2009), Caldera & Debande (2010)
Sweden	Nilsson, Rickne & Bengtsson (2010)
The U.S. & Canada	Kenney & Patton (2001)
The U.S. & the UK	Siegel et al. (2008)
Germany & Sweden	Sellenthin (2009)
Portugal & Spain	Arqué-Castells et al. (2016)
Italy, Norway & the UK	Fini et al. (2016)

All the mentioned studies were conducted in the context of one country, region, city or university. **Only several cross-country comparative researches on the performance of TTOs have been done so far**: the U.S. and Canadian case on contrasting the number and type of spin-offs produced by the universities in these countries (Kenney & Patton, 2001); university patenting situation in Germany and Sweden (Sellenthin, 2009); Portuguese and Spanish case on royalty sharing, effort and invention in universities (Arqué-Castells et al., 2016); and a longitudinal, multilevel study on institutional determinants of university spin-off quantity and quality in Italy, Norway and the UK (Fini et al., 2016).

Even though in 2003 Siegel et al. made a conclusion that cross-country empirical findings on the performance of TTOs cannot be compared because the differences among them are too big, in 2008 while investigating the U.S. and the UK TTOs Siegel et al. suggested a model for cross-country comparison based on data envelopment analysis. However, **so far there have not been cross-country researches conducted on reasoning the factors influencing the performance of TTOs on a larger scale. Therefore, this study is covering a major gap in the literature related to the performance of TTOs.**

2.4. Presumptions for New Empirical Research

Literature analysis revealed that there is a need for new empirical research related to subject on the performance of TTOs. **Following are the gaps indicated in the literature:**

- there is a lack of studies conducting a comparison among the performance of various TTOs at universities;
- European context on the performance of TTOs is studied much less than American;
- there is a lack of comparative cross-country studies;
- predominant researches are mainly based on couple factors influencing the performance of TTOs but not a complex of them;
- there is no clear distinction which of the factors are suitable for the European context;
- no study to date has classified the factors according to subject similarity.

Therefore, presumptions for new empirical researches are based on these gaps revealed analysing relevant literature.

3. RESEARCH METHODOLOGY

This chapter consists of four sub-chapters. The following issues related to research methodology are discussed: firstly, design of empirical research; secondly, reasoning of methodology; thirdly, research sample and organizational aspects; and lastly, anticipated research results and recommendations for further investigation.

3.1. Design of Empirical Research

The theoretical part of this work reveals the need to empirically investigate the reasoning of the factors influencing the performance of technology transfer offices. Even though the vast majority of studies have been conducted aiming to identify such factors, a lack of reasoning for them was introduced. Moreover, most of these researches were oriented to the local and national context, and only several cross-country studies were conducted. Therefore, as all countries in Europe have a high degree of variability in technology transfer performance, the aim of this study is to reason the factors which have an affect on the performance of TTOs at the members of ECIU, as research and technology transfer oriented universities. Even though each TTO has its organizational peculiarities, universities belonging to ECIU are considered as related in their innovation policy, and therefore, they were chosen as a context for this study. Possibilities to collect data have also implied the choice that there is a common policy in the area of technology transfer among the members of ECIU that aim to be one of the other learning partner universities which need data of this study. It is known that all universities are different thus their TTOs are diverse, and therefore there are no broad scope researches, but initiatives of action consolidation among ECIU partners are a good reference point for a research.

Purpose: To empirically reason the factors influencing the performance of TTOs in the context of ECIU.

Research object: Factors influencing the performance of TTOs.

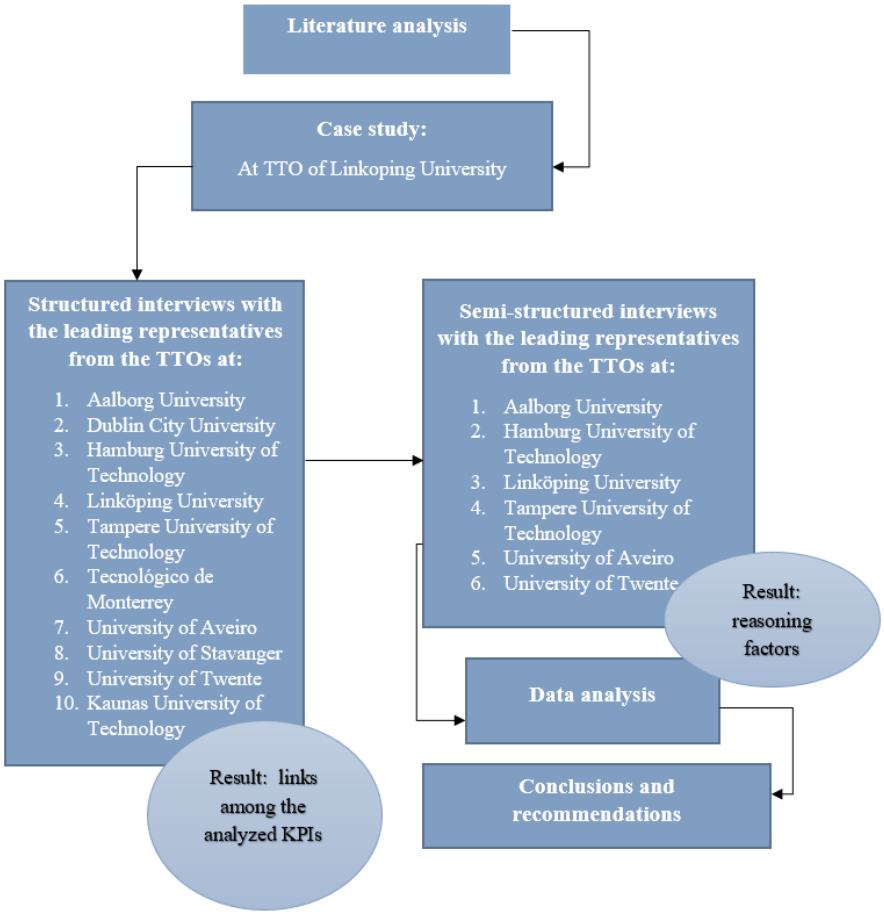

Figure 7. Design of the empirical research

Following purpose and object of the research, design of the empirical research is provided in Figure 7.

3.2. Reasoning of Methodology

The problem under consideration of this study is mainly in a managerial context. Management situations are usually difficult to quantify, and therefore the **qualitative research** was chosen. This approach is used when there is a need for comprehension and interpretation of the subject matter (Luobikienė, 2010). As it was emphasized earlier, by now the subject of this study has been investigated poorly, thus at this stage it is important to understand the essence of the phenomenon and to grasp the trends. The qualitative research method allows to identify variables which explain the behavior of the participants under investigation when theory is not enough. According to the authors Gaižauskaitė and Valavičienė (2016), this method is intended to reveal the nature of the phenomenon under investigation in its usual context; therefore, the area of qualitative research is often a daily routine, with a variety of activities and social issues that go away. The qualitative research does not have to test the theory (to

check the known statements) but to develop empirical facts-based theories (they are derived from the data obtained). Furthermore, the research evaluates the fact that approaches and practices differ because subjective perspectives and related social and biographical contexts do not match (Flick, 2014). The center of attention is the perspective of the participants in the research, subjective concepts and experiences, and everyday contexts.

Since the aim of the study is to see the internal situations through the practical insights of the representatives of TTOs at the members of ECIU, qualitative research method will allow to obtain the results. In order to achieve the latter, the constructivist approach was chosen which means the conduction of small language analysis: it is focusing on how representatives speak and what social actions are carried out through the language support (Melnikova, 2008).

One of the methods used during this qualitative research was **a case study** - the observation of visual, historical, interactional and other objects which describe the usual and problematic individual moments and meaning of life. The goal of the case study of this research is to investigate one case using all possible means. The case study allows to understand the case as deeply as possible in its natural environment with its complicated structure and content (Luobikienė, 2010). The case may be a person, group, episode, process, community, or any other unit of social life. All relevant data for the case is collected, and all obtainable data are organized according to the time periods. The case method gives the base for what is going to be investigated, the overall nature, the adaptation of the various facts to one event. The case study also provides an opportunity for an intensive analysis of many specific details that are simply missed using other methods (Punch, 1998). **Considering the fact that this research is based on the context of ECIU and Linkoping University (LiU) in Sweden is a member of this Consortium, the case study was conducted during a mobility visit in the period from 4th to 11th of February 2018 at TTO of LiU.**

In order to capture the most observant moments of the case study, the **field notes** were taken. Bernard (2011) distinguishes four types of field notes: jottings, a diary, a log and field notes proper. Two of them were used during this research: **jottings** and **field notes proper**. The first one, also called as scratch notes (Sanjek, 1990), are what the researcher gathers through the day, usually on the spot. Meanwhile the field notes proper are distinguished into three kinds: *methodological notes*, *descriptive notes*, and *analytic notes*. During the mobility visit the middle ones were taken. *Descriptive notes* are mostly based on two sources: watching and listening. It is trying to capture the details about "what's going on". It is also about asking the hosts to explain what the researcher sees and writing down their explanations.

Continuing the research an **interview method** was selected for data collection. This method allows to understand the realities and perspectives of the other people, to get to know their interpretation regarding approaches and attitudes in their own words (Tidikis, 2003). The base of the interview is open

questions which are expected to be answered as broadly as possible, as well as they are supposed to be honest and detailed which would allow to formulate the perspective of the research. According to the authors Gaižauskaitė and Valavičienė (2016), the interviews are conducted when there is a need for knowing more than what is written.

For this research the types of **structured and semi-structured** interviews were selected. For such cases the most commonly used methodology is individual, direct, face-to-face interviews. As TTOs at the members of ECIU are located in 12 different countries, due to the lack of resources and time there was no opportunity to conduct interviews face-to-face physically. Nevertheless, computer technologies and internet access allowed to take **the interviews using *Skype* program**. By communicating in this way, each person was left in his/her private, comfortable space. According to Seitz (2015), while using *Skype* program everyone can stay in a non-intrusive personal environment, therefore, qualitative interviews can be successfully conducted by using online video and audio communication.

Foremost, the **structured interviews** with 10 (out of 12) representatives from TTOs at the members of ECIU were conducted. This type of interview was selected in order to get the responses for the same questions in the same order. Usually structured interview is used to compare certain cases (Gaižauskaitė & Valavičienė, 2016). In order to proceed with this research, it was important to reveal the level of performance at all TTOs of ECIU. Therefore, **the first part of the structured interviews was regarding the input and output key performance indicators (KPIs) of each TTO in order to objectively indicate the links among KPIs**. It was merely the comparison of quantitative indicators which was not the main objective of this study but had to be verified. **Parallelly it was essential to identify how strongly certain factors influence the performance of each TTO based on the subjective perspectives** (see Table 8). KPIs and factors were chosen based on the literature analysis as well as on the experience gained while exploring the case study of TTO at Linkoping University in Sweden.

Table 8. Design and reasoning of the structured interviews

PART 1 of the semi-structured interview	
Aim: To identify the level of TTOs objectively.	
KPIs	**Supporting literature** (also see Table 4)
Input (number of TTO's employees, age of TTO, average period of time worked by employees at TTO, number of students and researchers at the University, ownership and profile of the University, annual TTO budget, average funding for one early stage spin-off or start-up, annual University's budget)	Kim et al. (2008), Siegel et. at (2007), Chapple et al. (2005), Siegel et. al (2005), Curi et. al (2012), Lee (2000), Thursby & Thursby (2002), Anderson et al. (2007), Caldera & Debande

Output (invention disclosures, patents, spin-offs, start-ups, university-industry joint research projects, revenues of university-industry joint research projects, events for attracting industry, events for the researchers, participation in international events, revenues from contracts related to R&D, revenues from licensing, revenues from consultations for enterprises)	(2010), Ustundag et al. (2011)
PART 2 of the semi-structured interview	
Aim: To identify the influential factors subjectively.	
The interviewees were asked to evaluate from 1 to 5 (1 - has no impact, 5 - has major impact): **How much do these factors influence the performance of your TTO?**	**Supporting literature** (also see Table 6)
Group of factors: *Human resource* **Factors:** - Proactive and motivated TTO staff - Business experience of TTO staff - Opportunities to improve the qualification of TTO staff according to their needs	Siegel et al.(2003), Siegel et al. (2004), Markman et al. (2005), Chapple et al. (2005), Conti et al. (2007)
Group of factors: *Strategy* **Factors:** - Clear TTO strategy with the steps of implementation - Awareness of University's scientific key points - Functioning and effective system of KPIs at TTO	Lockett et al. (2003), Friedman & Silberman (2003); Rasmussen et. al. (2006); Caldera & Debande (2010), Graham (2013)
Group of factors: *Culture/Mindset* **Factors:** - Informal relations and friendly atmosphere at the University - Invention disclosures to your TTO are performed at an early stage - Mostly researchers disclose the inventions to TTO	Siegel et al. (2003), Siegel et al. (2004); Jasinski (2009); Harman (2010)
Group of factors: *Organizational structure* **Factors:** - Period of time worked as an adviser/technology transfer manager at your TTO - Process management at TTO	Siegel et al. (2003), Markman et al. (2005); Caldera & Debande (2010); Secundo, De Beer & Passiante (2016)
Group of factors: *Economic incentives* Questions related to this group of factors were not prepared to ask because KPIs revealed the relative information. However, during the interviews certain topics related this group of factors were discussed (see the analysis of empirical results).	Anderson, T. R, Daim, T. & Lavoie, F. (2007); Chapple et al. (2005)
Group of factors: *Industry links* **Factors:**	Tahvanainen A. J. & Hermans R. (2011); Hulsbeck M., Lehmann E. E. & Starnecker A. (2013)

- Effective and regular TTO marketing campaign - Face-to-face contact between TTO and industry - Matchmaking events - Active marketing for scientific services provided by the researchers of the University	

As structured interviews were completed, the analysis of the results was done which revealed that **semi-structured interviews with the leaders of TTOs at the members of ECIU were needed in order to validate the reasoning of the factors distinguished during the structured interviews**. **Semi-structured interview** was chosen because of the method specification that allows to enquire additional questions during the interview if there is a need (Tidikis, 2003). Moreover, using this method there is a possibility to get useful information for the research, to adapt to a specific interview situation and interviewee as well. The questions for the semi-structured interviews were prepared based on the literature analysis and the results of the structured interviews. Therefore, **they were oriented to indicate the reasoning of the influential factors which are mainly distinguished in the literature and which were selected the most by the interviewees of the structured interview**s (see Table 9). Interview guideline was sent for all interviewees in order for them to prepare for the interviews in advance. Nevertheless, the structure of the interviews was flexible and easy going. As the questions were open, during the interviews the formulations of the questions were changing comparing to the ones in the guideline, however, not dismissing the main purpose of the study. **Full interview transcriptions are provided on a USB storage which is attached to this paper.**

Table 9. Guiding questions of semi-structured interviews targeting groups of factors

Guiding question(s)	Group(s) of Factors
- Introduce the backgrounds of yourself and your employees. - Is there any motivational system regarding the better performance of the employees at your TTO? If yes, what kind? - What kind of training activities do your employees receive? - Do you agree with the following statement: if an employee has a strong business background/experience, the period of time worked at TTO is not important. Please, elaborate.	Human capital
- Introduce the structure of your TTO. - Could you define what part of the work at your TTO is oriented separately to students, scientists and companies?	Organizational design and structure
- Who owns the intellectual property produced at your University? - Does your TTO have a strategy? If yes, what is the main purpose of it? - How do you measure the performance of your TTO every year?	IP strategy and policy
- How do you reach the industry or does the industry reach you? - How is the participation in the international events organized?	Industry links

- How does the financing for the start-ups and spin-offs operate?	Economic incentives
- How does your TTO encourage the disclosures of inventions? - How do the informal relations reflect in your work?	Cultural aspects

Ten structured and six semi-structured interviews were conducted. As the chosen context for this study was ECIU, the interviews were held with the representatives of TTOs at the members of ECIU. The purpose of the study required that the informants would know about the activities of their TTO well, be involved in the management of those activities and have a say in the decision-making process. Therefore, the representatives of the interviewed organizations were the leading persons.

The length of the semi-structured interviews varied from half an hour to an hour and a half. These **interviews were recorded** because the semi-structured interview is based on the conversation which makes it difficult to memorize and to resume its content from the memory. In addition, it was chosen to perform the analysis of the results according to the transcribed text, so the sound record is very important in order to keep the details intact. Transcribed text was based on word-to-word transcription, however, eliminating meaningless words and sounds. Similarly, linguistic nuances such as intonation of speech, pauses, speech volumes, spells, dialect, pronunciation and similar aspects of language stylistics were not evaluated during transcription of the texts as they do not affect the results of the research and do not play an important role in interpreting them. During the transcription of the text it was also eliminated unfinished expressions, incompletely spoken words, jargon expressions were paraphrased.

Transcribed interview texts were processed with qualitative content analysis. The latter was used by reading text repeatedly and progressively several times, categorizing it (also known as coding) into categories and subcategories, interpreting and finding logical interfaces and relationships. During the categorization the text was systematized and distributed into meaningful units, the supporting quotes for each subcategory were selected. In the course of qualitative content analysis, the end result was a single categorization system for all transcribed texts that would allow a subsequent comparison of the data, which would be in line with the categorization of factors envisaged at the beginning of the study, thus allowing conclusions to be drawn at the end of the study that are consistent with the purpose of the study.

It is essential to mention that during this study it was focused on ensuring **ethics**. Invitations to participate in this study were sent providing information on the topic and the purpose of the research, the arguments why the chosen organization is invited to participate were given. Information was also provided about the expected duration of the interviews and the contact details were given if additional questions would have been occured for the interviewees. The timing for the interviews was agreed with the informants in advance at a convenient time for both sides. Before the interview, a question was asked

whether there was no objection for the interview to be recorded, as well as ensured that the names of the informants would not be mentioned in the study and the records of the interviews would not be distributed. The ethics issue was also evaluated by transcribing the text, i.e. the names or/and surnames of the persons who were mentioned in a certain context during the interview were not mentioned in the transcribed text if that may be unacceptable to the person in question. In this way, the aim is to ensure that the information obtained in the course of the investigation does not cause any conflict of interest and that it does not compromise, injure or otherwise violate the privacy of the individuals mentioned in the interview.

3.3. Research Sample and Organizational Aspects

Kaunas University of Technology (KTU) is a member of ECIU. The latter is the leading international consortium of research intensive universities, with collective emphasis on innovation, creativity and societal impact, driving the development of a knowledge-based economy (ECIU, 2018). Its mission is challenging conventional thinking in innovative teaching and learning, entrepreneurship and societal impact of research and EU policy and research. Innovation driven universities are eager to contribute to the welfare of society by sharing their knowledge through novel products and services. The process of such knowledge transfer is long and challenging, however, the impact is enduring and promising: for those delivering as well as for those receiving and consuming.

Besides KTU, the members of ECIU are the following 11 universities: Aalborg University, Dublin City University, Hamburg University of Technology, Linköping University, Tampere University of Technology, Tecnológico de Monterrey, The University of Nottingham, Universitat Autònoma de Barcelona, University of Aveiro, University of Stavanger and University of Twente. The members of ECIU are mainly research oriented public universities with the different number of students and scientists as well as varying budgets (see Table 10).

Table 10. Information about ECIU universities

University	Ownership	Profile	Number of students	Number of scientists	Budget, mln EUR
Tampere University of Technology	Private	Research	8 000	800	139
Linköping University	Public	Research	27 000	4 000	362
University of	Public	Applied	10 000	1 500	304

Twente					
Aalborg University	Public	Research	20 800	2 100	382
Tecnológico de Monterrey	Private	Applied	90 000	10 000	>250
University of Aveiro	Public	Research	13 250	950	105
Kaunas University of Technology	Public	Research	10 500	950	54
Hamburg University of Technology	Public	Research	7 800	690	123
University of Stavanger	Public	Research	11 000	1 000	166
Dublin City University	Public	Research	17 000	440	166
Universitat Autònoma de Barcelona	Public	Research	43 000	3 600	313
The University of Nottingham	Public	Research	45 500	7 000	737

For this research the context of ECIU was chosen because of several reasons. **Firstly**, all members of ECIU are oriented to innovation and entrepreneurship, therefore, they are eager to contribute to the welfare of society by sharing their knowledge through novel products and services which alerts that technology transfer is in the priority list. **Secondly**, peer learning is confirmed to be effective (Boud et al., 2002), thus it is beneficial to know the approaches of the members at the same pool to the similar situations and to possibly apply the proposed solutions. **Thirdly**, all these universities own actively operating TTOs. And **lastly**, the access to the relevant data was available due to the fact that Kaunas University of Technology is a member of ECIU.

The invitations for interviewing were repeatedly sent to 12 TTOs - each member of ECIU. 10 answers were received, thus there were 10 semi-structured interviews conducted. As for the structured interviews, 6 organizations were available during the period of research conduction. Therefore, it is relevant to claim that the size of research sample is representative for the qualitative research.

Research plan:

1. *Preparation.* Synthesis of theoretical material, deepening of the problem, preparation of empirical research methodology.

2. *Case study*. Observation and analysis of the environment.

3. *Preparation for the semi-structured interviews*. Formulation of questions, analysis of relevant issues.

4. *Interviewing*. Conducting structured interviews.

5. *Data analysis.* Analysis and synthesis of primary and secondary data, deepening of the specifics of organizations.

6. *Interviewing*. Conducting semi-structured interviews.

7. *Data analysis.* Analysis and synthesis of primary and secondary data, analysis of transcribed interview texts, case comparisons, and presentation of aggregated results.

8. *End of the research*. Presentation of discussions and recommendations, formulation of conclusions.

Research process. In the beginning of the study the theoretical analysis was done along with the gathering of the contextual information. Understanding the context has allowed to have deeper knowledge about the situation and the problematic aspects of it. This knowledge was important during the interviews to better understand the answers of the informants and to formulate additional questions.

After analyzing the theory and contextual situation the case study was done. The latter was implemented by visiting TTO of Linkoping University in Sweden. The name of this TTO is *LiU Holding*. During this week-length visit (4-11th of February 2018) there were 12 formal and non-formal meetings held together with 17 people representing various positions: representatives of LiU Holding (advisors, heads of different units and project manager), researchers and administrative staff of Linkoping University, engineer working at the research institute in Norrkoping and Lithuanian Honorary Consular who is also an owner of his business in Sweden. 3 interviews with the heads of different units (*LiU Innovation, LiU Invest, LiU Relation, Spetsa AB* and *Unitalent AB*), lasting approximately for an hour each, were recorded and transcribed.

Based on the theoretical and case study analysis the questions for the structured interviews were formulated. Such interviews were conducted with the representatives (mainly - leaders) of 10 TTOs at the members of ECIU (Aalborg University, Dublin City University, Hamburg University of Technology, Linköping University, Tampere University of Technology, Tecnológico de Monterrey, University of Aveiro, University of Stavanger and University of Twente). In order to deepen the knowledge gained from the structured interviews, additionally the semi-structured interviews were conducted with the heads of TTOs at Aalborg University, Hamburg University of Technology, Tampere University of Technology, University of Aveiro and University of Twente. These semi-structured interviews were recorded and transcribed.

Before all interviews the purpose and the subject of the research were briefed to the informants. The transcriptions of the interviews were used for the analysis of the results.

Research restrictions. In the course of the research, qualitative access was selected and a limited number of informants was questioned. Although this type of investigation allows for more in-depth insights and better understanding of situations, this creates limited possibilities for generalizing the results of the research. As a restriction of the research the subjectivity of personal experience provided in each case should also be mentioned. Given the small number of interviewees and the different positions of the informants, this has created difficult conditions for an objective assessment of the positions of each informant and their importance in a more general sense.

3.4. Anticipated Research Results and Recommendations for Further Investigation

By conducting this study, it is expected to take a closer look at the situations of the TTOs at the members of ECIU, to compare them, to try to recognize commonalities and differences and to reason the factors influencing the performance of TTOs at the members of ECIU. As the context of this research is wide and cross-country, it is within reason to anticipate that the results of it will broaden the perspective on factors influencing the performance of TTOs. That would allow the leaders of TTOs to improve the internal processes at TTOs as well as to initiate changes on the external forces which have impact on the performance of such offices. Furthermore, ECIU partners will benefit from this research by learning from good case practice, because their objectives are the same and know-how exchanges are very valuable in this case. From the scientific point of view this study is expected to reveal the limits to what extent the experiences of one TTO could be adapted to the other ones or could not due the external factors.

Thus, for further investigation it is recommended that the results of this research would be used for quantitative testing, as this would allow an objective generalization of them. Moreover, this research can be used to conduct other related investigations. As our study adds to the so far limited cross-country analyses of the influential factors, further recommended studies are qualitative research with cross-country TTOs in various contexts while including more parties involved in the technology transfer processes (scientists, people representing industries, business developers, etc.). Furthermore, it would be meaningful to conduct research on trying to find what organizational structure is the most suitable for TTOs at universities, what kind of management practices works best and to follow them in adaptation. To add, this study is a pioneer in the context of ECIU, therefore, later on more aspects related to this topic could be explored as it is so complex. Such researches would allow to obtain more practical insights and knowledge about the performance of TTOs, and that would help to develop the functionality of them.

4. REASONING OF THE FACTORS INFLUENCING THE PERFORMANCE OF TECHNOLOGY TRANSFER OFFICES AT THE MEMBERS OF EUROPEAN CONSORTIUM OF INNOVATIVE UNIVERSITIES

As the purpose of this study is to reason the factors influencing the performance of TTOs at the members of ECIU, in this chapter there is analysis provided aiming to achieve this goal. Therefore, ***fourth chapter is consisting of four sub-chapters***: the findings of the case study at LiU Holding AB are presented in the first sub-chapter, the analysis of the results from the structured interviews with ten representatives of TTOs at the members of ECIU is depicted in the third one, the analysis of the results from the semi-structured interviews with six leaders of TTOs at Linkoping University, University of Twente, University of Aveiro, Tampere University of Technology, Hamburg University of Technology and Aalborg University are described respectively, and comparison of the cases together with generalization of the results are provided in the final chapter.

4.1. Case Study of LiU Holding AB

Case study was done at TTO of Linkoping University (LiU) in Sweden called LiU Holding AB during the mobility visit from the 4th to the 11th of February 2018. Innovation related context of Sweden and the results of the analysis of this case study are described below.

Context of Sweden

To start with, case study was conducted at Linkoping University in Sweden because **Sweden is an *Innovation Leader* among the European countries**, according to European Innovation Scoreboard 2017. Sweden also ranks in a second place at Global Innovation Index 2017 which provides detailed metrics about the innovation performance of 127 countries. This Index reveals the infrastructure of the country for possible actions on innovation and creation. In the case of Sweden, this country has strong outputs, such as patents and research publications, as well as steady basis for the development which regards stable politics and high-quality education.

Close collaborations with science and enterprises as well as with public sector are the main reasons why Sweden is the leading country. In 2016 it was invested 3,3 percent of gross domestic product (GDP) in R&D comparing with Europe's target of 3 percent of GDP by 2020. Based on RIO Country Report 2017, Sweden focused on increasing the bond between science and business from 1900.

Since then there was a focus on funding instruments which could help to improve cross-sectoral collaboration. Swedish business enterprise R&D expenditures are among the highest in Europe corresponding to two thirds of total R&D investments in Sweden. Sweden has a strong high-performing business sector, there are large and innovative, export-oriented, internationalized enterprises operating in different industrial sectors in this country. In Sweden the most of R&D business is performed by few large multinational companies. However, the aim is to reduce the dependency on large companies and support the performance of small and medium enterprises (SMEs) on R&D by improving their conditions in order to raise the amount of high-tech activities in these firms. Moreover, during the recent years Swedish economy was transforming to more service-oriented economy with creative labor force. Furthermore, in 2015 value added by knowledge-intensive services was 40,7 percent comparing to EU average of 23,6 percent.

The Swedish government manages national research and innovation (R&I) system through the Research Bill, the Energy Research Bill (both released every 4 years) and the National Innovation Strategy up to 2020. The bills focus on funding and research priorities for 2017-2020. There is extended network in Sweden with companies and organizations in private and public sectors working on cross-sectoral collaboration with the aim to develop new products and services in order to increase the sustainable growth (see Table 11).

Table 11. Organizations involved in technology transfer process in Sweden

(Based on: RIO Report Sweden 2017)

Organization	Sector	Activity
KK-stiftelsen (The Knowledge Foundation)	Public-private	Goal is to stimulate the link between academia and industry.
SSF (The Swedish Foundation for Strategic Research)	Public-private	Independent organization that supports research in the natural sciences, engineering and medicine.
Vinnova (Sweden's Innovation Agency)	Public	Focuses on innovations linked to R&D, ICT, biotechnology, working life, materials, transportation and bringing products and services to production. Charged with the implementation of the National Innovation Strategy. Reporting to the Ministry of Enterprise and Innovation.
Swedish Research Council (FORMAS)	Public	Funding basic research and providing advice. Reporting to Ministry of Education and Research.
Swedish Energy Agency	Public	Supporting the development of renewable energy technologies, smart grids etc. Reporting to Ministry of the Environment and Energy.

Swedish Defense Research	Public	R&D of methods and technologies, investigative work for the Swedish Armed force. Reporting to Ministry of Defense.
Research Council for Health, Working Life and Welfare (FORTE)	Public	Funding research on health, working life and welfare. Reporting to the Ministry of Health and Social Affairs.
Tillväxtverket (The Swedish Agency for Economic and Regional Growth)	Public	A governmental body which aims to foster greater enterprise growth and sustainable, competitive business and industry in Sweden. Reporting to Ministry of Enterprise and Innovation.

Sweden is actively promoting academia-university collaboration by focusing on getting university researchers to spend time in public or private sectors while performing collaborative projects. Furthemore, RISE (Research Institute of Sweden), which is owned by the private consortium and the government, is the main actor in non-university research sector where academia, industry and public sector collaborate to ensure the competitiveness of the Swedish business community on an international level.

To sum up, Sweden is the country where the focus on R&I is very strong and there are many initiatives and tools which allow step-by-step implementation of the National Innovation Strategy. The evaluation of economic and political environment leads to strategic planning on the national level in order to increase the cross-sectoral collaboration and the development of new sustainable products, enabling SMEs to contribute to the development of high-tech sectors.

Analysis of the Case Study

Linkoping University is a leading university which closely cooperates with business and society. By conducting world-leading research in a variety of fields, this University also offers innovative educational programs with a clear vocational focus. University has more than 27 000 students and 4 000 employees in four different campuses.

LiU is an active actor in the innovation ecosystem in the region of Linkoping and Norrkoping. TTO of LiU is a separate company, called **LiU Holding AB** and 100 percent owned by the University. It was established to utilize the knowledge from the university while bringing more benefits for society. In 2015 it was an anniversary of 20 years between LiU and LiU Holding AB collaboration. Structurally this organization is divided into two separate units - **Liu Holding AB** and **Innovation and Collaboration**, which are responsible for different functions (see Figure 11).

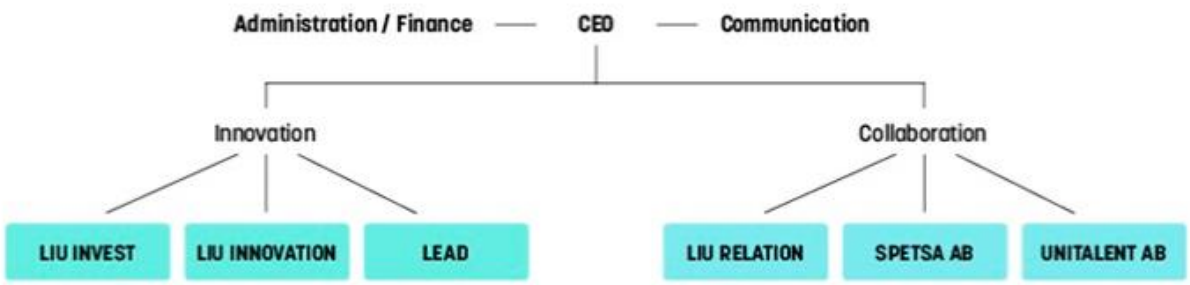

Figure 8. LiU Holding AB structure

(Retrieved from official website of Linkoping University)

Innovation unit includes the sections of **LiU Invest** that is engaged with the investment procedures, **LiU Innovation** which is responsible for the development of the innovation at the University and **LEAD** which is a business incubator in Linkoping and Norrkoping. **Collaboration** unit is consisting of **LiU Relation** which is responsible for business relations development with partners and investors in the region, **Spetsa AB** operates as a business consultancy company and **Unitalent AB** functions as students' consultancy company. During a week-length mobility visit in Linkoping, meetings with the representatives from all sections except LEAD (because of the occupied schedule) were arranged. Additionally, it was an opportunity to meet and talk to Lithuanian scientists working and doing researches in Linkoping. Moreover, meetings with the researcher working at RISE (Research Institute of Sweden) and Lithuanian Honorary Consul in Sweden were arranged.

LiU Innovation is the section that provides consulting services for the students, researchers and staff at Linkoping University. Aim of this unit is to assist the development of a product or service from idea in order for it to be ready for market. At Liu Innovation there are 11 advisors who provide free of charge and confidential consultations in such areas as startups, financing, patenting. During the visit the first meeting was held with 2 innovation advisors: one of them is responsible for social innovation and the other is working with the students. As Linkoping University has two campuses - one based in Linkoping, the other - in Norrkoping, both of them part of the time are located at those different campuses. Additionally, few more meetings were organized with innovation advisors representing IT, e-health and med-tech sectors and coaches for sustainable venture design and start-up development. During these meetings it was found out that ***LiU Holding AB has a flat organizational structure*** in which everybody has a direct contact with the top management. This kind of structure creates inspiring culture and empowers employees to act independently and be more proactive. Furthermore, it was emphasized that ***LiU Holding AB is a learning organization*** as well. This means that an organization is willing to take risks with new ideas, support employees, develop their critical thinking, allow mistakes and learn from experiment and experience.

Representatives from LiU Innovation also shared that all of them have different backgrounds and experiences. This ***transdisciplinary approach allows them to be more creative and look for unusual ways to solve the problems***. ***Business background*** was mentioned as one of the most important factors which influences their performance. Most of the advisors run or used to run their own startup companies or have experiences and strong relations with the enterprises. During the meetings with the researchers and students who come to share their ideas, ***advisors are used to use a variety of methods and techniques*** (NABC, GROW) to make meetings more efficient. It was also mentioned that ***scientists and students are concentrated to create their research-based products and services based on 17 Sustainable Development Goals (SDGs) set up by the United Nations*** with the aim to transform the world to the better place. To continue, such phenomenon as ***professor's privilege exists in Sweden*** which means that the intellectual property rights belong to the researchers and students. Moreover, according to the representatives from LiU Innovation unit, ***communication and contact among people is crucial***. Therefore, ***every year LiU Holding AB organizes many matchmaking events in order to connect researchers with enterprises, researchers with students, students with enterprises and vice-versa.*** These kind of events stimulate generalization of new ideas, motivate young and experienced people to get along for one aim, as well as to create and discover new opportunities how to convert the world into a better place.

LiU Invest is a section which is managed by one person. The main function of LiU Invest is to find and build financial perspectives for startups and spin-offs. Knowledge commercialization process is controlled by working closely with LEAD and LiU Innovation. Because of the ***wide network that the representative of LiU Invest has***, there are no difficulties to invite potential investors to evaluate ideas and decide if they are worth continuation of development, need to stop being developed or need to adjust following the advices and keep developing. He also mentioned that business angels, venture capitals and such governmental organizations as VINNOVA are options for an idea to get financed and to be developed to a product or service which is suitable for the market. Despite that, ***LiU Invest also has its own budget to invest up to 50 000 EUR in the development process of new idea.***

The last meeting was held with the representatives from three sections at LiU Holding AB: *LiU Relation, Spetsa AB and Unitalet AB.* These sections represent the Collaboration unit at LiU Holding AB. *LiU Relation* develops connections with local actors and SMEs by looking for external financial support. It is also responsible for strategic partnerships and the sustainability of relations. During the meeting a presentation was done on ***how actively companies are involved in the educational programs*** in order for students to get more practical experience and for companies to get the solutions for their problems free of charge. ***Advertising success stories was mentioned as one of the ways to reach attention of the companies in order to include them into collaboration***. Moreover, *LiU Relation* is actively ***involved in the processes of organizing events dedicated to gather researchers and business***

people in one place in order for them to share the knowledge and to start cross-sectoral collaboration. However, there are researchers who are not willing to work with industries because they do not see a need to do that or because by using their *professor's privilege* they are not intending to start business with their ideas which were created during the certain time. Therefore, *LiU Relation* revealed that ***it is very important to be physically close to the researchers and to gain their recognition and trust in order to stimulate innovation and technology transfer process from academia to society through industry***.

Spetsa AB is a consultancy company operating within LiU Holding AB. It provides tailored assignments for companies based on researchers' knowledge. The main purpose of this section is not different from the overall aim of TTO of LiU - to increase university-industry collaboration. Researchers should be ambitious to engage with companies in order to do researches in fields relevant for society. Therefore, *Spetsa AB* is facing such challenges as timing, when business wants to get the results fast and researchers are occupied, for instance, for a year ahead. Furthermore, there are researchers who are not motivated to work with companies because they do not see the value and money is not an incentive. Representatives of this section emphasized the ***importance of correct communication with the researchers in order to foster them for cooperation with the industries***.

Unitalent AB is students' consultancy company as well as *Spetsa AB* owned by LiU through LiU Holding AB. The focus of this firm is to match students from LiU with industry by offering customized assignments from business and municipalities. Companies pay for the projects that students complete during certain time of period according to the field and the need of the company. In this case, there is a possibility for students to get practise and ensure future employment as well as to gain knowledge coming straight from the business.

As it was mentioned above, besides meetings inside LiU Holding AB there were several additional meetings with the other actors in innovation ecosystem in Linkoping area arranged. During these meetings, additionally to the ones within LiU Holding AB, it was notified that ***Swedish society is highly trusting in governmental system***, thus this enables smooth and continuous process of work until there are certain results achieved. ***Clear national focus on innovation and R&D stimulates growth of the region and enables more actors of the ecosystem to participate in the process. The latter is lead by the provision of financial and social instruments.*** Researchers from Lithuania and Honorary Consul also confirmed that ***communication and networking is an essential part of this ecosystem, and the collaboration among the different fields, sectors and even countries can bring beneficial results***.

4.2. Analysis of the Structured Interviews

One of the purposes of the structured interviews was to find out the level of the performance of each TTO at the members of ECIU. Therefore, the first part of the structured interviews was regarding

the input and output KPIs of each TTO. The representatives, who were qualified enough to answer the questions, from 10 (out of 12) TTOs were interviewed. After distinguishing the main four input (*number of employees at TTO, age of TTO, university's budget* and *TTO's budget*) and output (*disclosures, spin-offs, start-ups* and *university-industry joint research projects - per year*) KPIs and analyzing them, it turned out that except the case of TTO at Linkoping University **no links emerge from the data** (see Table 12). For instance, the age of TTO does not reflect in the number of spin-offs: TTO at Aalborg University is functioning for 18 years and the yearly spin-off number is only 2, meanwhile TTO at Tampere University of Technology is present only for 5 years but the average yearly number of spin-offs is 7. Another example - high TTO's budget does not mean the best output: the budgets of TTOs at Hamburg University of Technology and University of Stavanger are more than 1 million euro but the yearly start-up number is respectively 4 and 5, meanwhile the budget of TTO at University of Twente is up to 0,5 million euro and the average yearly number of start-ups is 10. **An attempt to find the links among KPIs was based on the hypothesis found in the literature.** It was merely the comparison of quantitative indicators which was not the main objective of this study but had to be verified. **However, tangible effects have not been detected.**

Table 12. Input and output KIPs of ECIU universities

University	Input KIPs				Output KIPs			
	Number of employees	Age of the TTO	University's budget, mln EUR	TTO's budget, mln EUR	Disclosures	Spin-offs	Start-ups	University-industry joint research projects
Tampere University of Technology	4	5	50-250	>1	75	7	20	500
Linköping University	28	23	50-250	>1	280	25	25	40
University of Twente	6	8	>250	up to 0,5	45	5	10	0
Aalborg University	5	18	up to 50	0,5-1	70	2	10	548
Tecnológico de Monterrey	12	13	>250	0,5-1	30	5	5	100
University of Aveiro	12	12	50-250	0,5-1	28	2	8	20
Kaunas University of Technology	12	5	50-250	0,5-1	25	0	9	12
Hamburg University of Technology	35	25	50-250	>1	25	2	4	150
University of Stavanger	6	15	50-250	>1	125	0	5	30
Dublin City University	8	10	50-250	0,5-1	26	2	2	73

*The numbers marked in yellow mean the highest scores in certain KPI.

As subjective perspectives matter as much as objective metrics in order to define the performance of TTOs, it was important to indicate the main factors influencing such performance. Therefore, the second part of the structured interviews was based on the opinion of the interviewees and consisted of the factors, the importance of which the interviewees had to evaluate using the Likert scale: 1 meant *"has no impact"*, 5 - *"has major impact"*. After summarizing the results, it was found out that the interviewees gave the highest scores (more than 70 % of the respondents evaluated at 4 and 5 on the Likert scale) to the following impact factors (see Figure 9):

- **clear TTO strategy with the steps of implementation**;
- **proactive and motivated TTO staff**;
- **business experience of TTO staff**;
- **informal relations and friendly atmosphere at the University**;
- **face-to-face contact between TTO and industry**;
- **matchmaking events**.

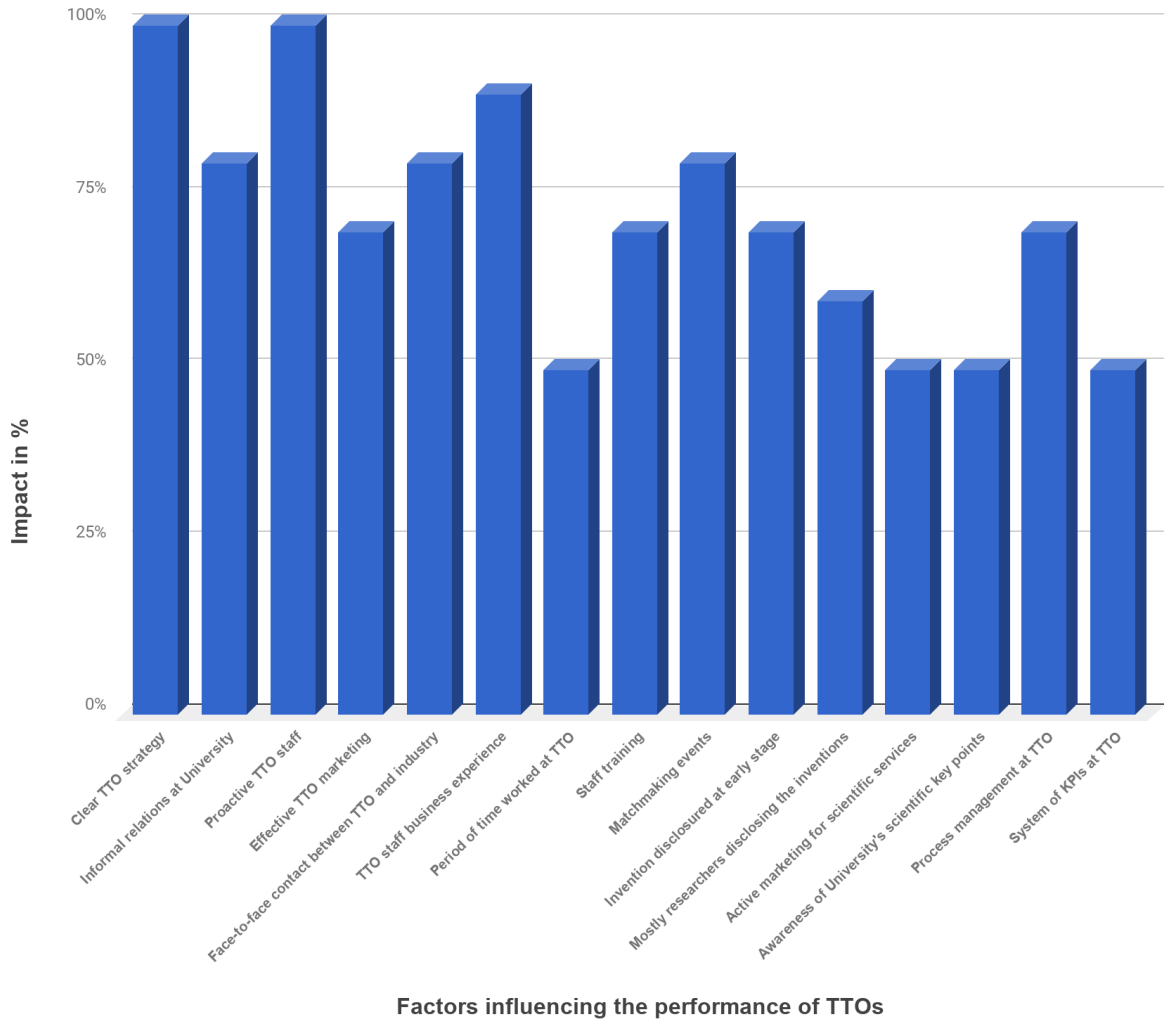

Figure 9. Factors influencing the performance of TTOs indicated by the interviewees.

Two leading factors - *clear TTO strategy* and *proactive TTO staff* - are related to organizational design and structure as well as to human capital which is highly emphasized in the literature (Markman et al., 2005; Friedman & Silberman, 2003; Chapple et al., 2005; Secundo et al., 2016). Meanwhile factors reflecting the lowest percentage (*period of time worked at TTO, active marketing for scientific services*, *awareness of University's scientific key points* and *system of KPIs at TTO*), however, still in the list, are barely mentioned in the analyzed literature.

Hence, the results of structured interviews triggered the necessity to indicate the reasoning behind. Thus, based on them and literature analysis, semi-structured interviews were conducted which enabled to reason the factors influencing the performance of TTOs in a cross-country context.

4.3. Analysis of Semi-structured Interviews

Semi-structured interviews were conducted with six leaders of the technology transfer offices at Linkoping University, University of Twente, University of Aveiro, Tampere University of Technology, Hamburg University of Technology and Aalborg University. The analysis of the interviews is described respectively.

TTO of Linköping University (LiU Holding AB)

As it was mentioned before, the case study was conducted at LiU Holding AB which is TTO of Linköping University and is owned by it. During the visit meetings were held with the representatives from each unit who were able to provide information about most of the processes inside the organization, as well as to share their personal experiences and insights regarding the performance of technology transfer office at LiU.

LiU Holding AB is operating for 23 years. During this period of time it has assembled significant experience and knowledge about how to commercialize new ideas and researchers' excellence as well as how to include industries into cross-sectoral collaboration. Meetings with the representatives of each unit were beneficial in order to understand the system and the processes of TTO at Linköping University. Therefore, in order to reason the main factors influencing the performance of this TTO, **semi-structured interviews with the leaders of Collaboration and Innovation departments were conducted**. The opinions expressed regarding the topic is summarized in categories and subcategories (see Table 13), and the full context of them is provided in the interview transcript (see USB storage attached to the study).

Table 13. Comments of interviewees from LiU Holding AB on the factors influencing the performance of TTOs

Groups of Factors	Factors	Comments of the Interviewees
Economic incentives	Investors	"<...> several business angels who have invested in several of those companies <...>" "<...> we try to form a consortium of investors who invest in this company <...>"
	Governmental support	"We apply for governmental projects."
Organization design and structure	Unit of TTO working with students	"My part. Unitalet is Students Consultancy Company."
	Unit of TTO working with researchers	"I work as a CEO at a consultancy company called Spetca."
	Unit of TTO working with enterprises	"Some of them are contacting us - LiU Relation, and we look at what is the best for this company."
	TTO is a separate holding company	"We are LiU Holding company."
IP strategy and policy	Process management	"We also do self-evaluation selection in order to get feedback from the companies because then you can build your own improvement on that."
	Following KPIs	"We have sales' goals."
	IP belongs to university	"The professor's privilege that they actually own their own ideas."
	TTO strategy	"I imagine LiU Holding has a vision and strategy but then each part has their own way."
Human capital	Period of time worked as an advisor/manager	Comments were not made.
	Staff training	"If someone needs an education we have such opportunity."
	Technical knowledge	Comments were not made.
	Business experience	"I have always worked with business companies."
Industry links	TTO marketing campaign	"We also get out to the university; inform them that we are a possibility for them to work."

	Networking	"So all of us are very much outside the university to meet different kinds of companies."
	Marketing campaign for scientific products	"In addition, municipalities, government inform about university before, so we are selling our products to them so they can pay for us."
	Industry analysis	Comments were not made.
Cultural aspects	Researchers disclose the inventions	Comments were not made.
	Informal relations at the University	"For all of us to build up the knowledge that we are here and to have good relationships and connections to the researchers."

During the interviews most of the interviewees expressed **strong positive position regarding the financial support from the Swedish government**. The possibility to get such support was expressed by saying: *"We apply for governmental projects. So some of the projects from the European Union funds."* The agency supporting innovations linked to R&D and bringing products and services to production called VINNOVA was mentioned by all representatives from different units. As it is already known, Sweden has a focus on helping SMEs to implement R&D into their activities in order to innovate and become a part of increasing cross-sectoral collaboration with focus on benefitting for society. Considering this fact, it is clear that representatives are **well acquainted with the financial instruments and are used to adopt them in order to get the results from academia-industry collaboration** (*"research and grants to apply for").* Regarding the investors, the head of LiU Invest, while representing the investment process for new ideas, mentioned **active involvement of investors** *("we try to form a consortium of investors who invest in this company"*).

Even though LiU Holding AB is a company which is owned by the University, a few more companies, which generate revenues and operate as consultancy companies (such as Spetsa AB and Unitalent AB), are established within this holding. There is also LiU Innovation unit which is directly working with the students and assisting them in developing their ideas into products as well as providing guidance in commercialization and entrepreneurship activities. Based on this information, it is evident that t**his TTO plays an important role at the University's knowledge transfer process**. **Even though there are separate units focusing on different aspects of the University, in the end they all are brought for one aim - to innovate, create and collaborate**.

During the interviews the aspect of professor's privilege was discussed. At first it can seem that this privilege stimulates researchers to be open and willing to commercialize their ideas. However, there are some challenges related to that as well: *"We have to convince the researcher to do something with the results <...>"*. It means that even though a great technology might be created by the researcher, it

can stay laying in the drawer without any right to be commercialized by the University. In the end **TTO has to find the way how to convince the professor to bring the results to the market**.

To continue, each unit of LiU Holding tends to have its own strategy setting up the goals which are expected to be achieved in the future. For one of them it is important *"to count how many businesses you have to do during a year"* because it is focusing on generating revenues. Due to the fact that the development of the relations and the attraction of external actors are the main goal, the representative from another section reveals that they have *"goals on how many people we are going to meet <...> how many collaborations we are making"*. Therefore, **KIPs are used to measure the level of the unit as well as to point out to which direction it has to shift**. Furthermore, **self-evaluation is considered as a tool to operate more effectively and efficiently**.

What's more, during the visit it was found out that the professionals working at LiU Holding have **a wide range of experiences**. Therefore, **while gathered in one place and providing professional services for researchers, companies and students, they have an added value for the organization**. However, **the most commonly required background in this TTO is business experience** (*"I was running my own company - we had a lot of cooperation with the university").* It is also common to have trainings according to the needs of the staff members working at TTO: *"If someone needs an education we have such opportunity"*. Moreover, most of the personnel in LiU Holding run their own businesses next to their daily work as advisors or at least they have education and work experience related to business. Therefore, **additional industry analysis is not necessary because they are always in touch with business sector and ready to consult the interested parties by offering optimal solutions**. Furthermore, the advisors have their own connections with the enterprises, and that enables them to receive the information about the urge of innovations within organizations.

To continue, while talking about the industry links, firstly, it was found out that LiU Holding AB devotes much time for networking: "*we have a collaboration with the other actors in the innovation system", "one of my colleagues is working in the municipalities in five different areas, so he is going to meetings with the companies and other organizations the whole day".* Secondly, the aim of TTO is to transfer the inventions of the researchers into the society through LiU Holding (*"the purpose is to reach out with the excellence they have, to help companies, government"*) as well as to stimulate companies to do more applied science and start being innovate within (*"maybe they know a person at the university and they ask him or her: 'Can you do this for us?'"*). Following this mindset, during the years TTO at LiU developed strong and long lasting relations with some of the biggest multinational companies in the region (*"strategic partnerships with some big companies, such as ABB, Ericsson, are handled within the university, within the holding company"*). This attitude helps to shape correct image about TTO and to reach out the other companies easier. **Reciprocal communication between researchers and companies is also encouraged at LiU Holding AB**: *"we have a day where the companies can meet*

researchers from university to discuss these questions", "we have a lunch club where the researchers talk to people from the companies", "we have Society Quest in different subjects". **Such events as Venture Arena, Deep Quest, lunch, pitching meetings, organized for the researchers working in the different fields at Linkoping University, and other were mentioned as a way to build up the bridge for communication**. Students are also involved in the matching events which are oriented to embracing experience and starting collaboration with the researchers (for instance, already for 12 years lasting Sommarmatchen event organized during the summer) and the companies (Unitalent, Demola): *"we do matching events where we try to match the entrepreneurs with the researchers".* According to the representatives of this TTO, **matchmaking events are relevant if the purpose is to connect the people from various sectors with different mindsets and experiences**. It is a good option to gather them in one place, let them discover common topics and afterwards - to assist with the development of the new projects.

To add, **the need for informal relations between the researchers and the advisors** from LiU Holding AB was emphasized by the interviewees as well: *"I think we have to work more inside the university just also to show what we can help the researchers with".* It is also evident that the personnel of TTO is continuously looking for the recognition of the researchers and is trying to reach out to them *"so that they feel they are appreciated".* **In order to stimulate researchers for the cross-sectoral collaboration, TTO has to prove the added value which it can create for the professors and the society**. Furthermore, **it is not less important to gain trust from the industries in order to be useful for Swedish society**.

To sum up, during the interviews several factors influencing the performance of TTO at the LiU were reasoned. First of all, professor's privilege enables the researchers to decide if they want to be a part of a new spin-off or to license the results of their inventions or not. Secondly, the diversity of the backgrounds and business experience is the reason for an effectiveness of TTO at LiU. Following LiU Holding performance it is evident that the advisors, who do not have any experiences in how to create or run the company, cannot provide professional advices to the others. Thirdly, tools and methods about how to take specific decisions related to development of new ideas, questions of investments, etc. are a part of daily approach for the employees of TTO. Lastly, matchmaking concept, which is implemented by the personnel of TTO and the members of academia (students and researchers) who are encouraged to interact with each other on daily basis as well as during specified events in order to get familiar with the innovation ecosystem and to develop new ideas, is a way to build up trust and confidence for all participating actors.

TTO at the University of Twente

Global Innovation Index 2017 ranks the Netherlands in the third place, just after Switzerland and Sweden. It reveals the Netherlands as a country leading in business sophistication (especially knowledge absorption - ranked first) and knowledge and technology outputs (second in the ranking). According to the European Innovation Scoreboard 2017, the Netherlands is among the Innovation Leaders and gets the last seat among the top five. In the Netherlands relative strengths of the innovation system are in attractive research systems, human resources, and linkages. One of the actors creating the latter ones are universities, and among them - the University of Twente.

The University of Twente (UT) represents itself as the pioneer in fusing technology, science and engineering with social sciences to impact the world around us. Established in 1961 as the Twente Technological University of Applied Sciences, today in QS Global World University Ranking 2018 it is at 179 place with the evaluation of very high research outcome. There are more than 9000 full time equivalent students enrolled at the University and more than 900 academic staff working there.

As it is declared by the UT, today's students are tomorrow's professionals. Therefore, the intensive contact with national and international industrial partners is at the core of the University's perspective. For that reason, **the UT has a department within the University which carries out technology transfer function**. However, besides that, the UT is one of the shareholders of TTO which is a holding company called **Novel-T**. The latter is a regional organization because the founders of it are not only the University of Twente but also Saxion, the Enschede local authority, Regio Twente and the Province of Overijssel. Therefore, this organization plays a major role in shaping the ecosystem for innovation and entrepreneurship in the region of Twente. The latter is recognized as the most innovative region in the Netherlands which is highly focusing on scientific and economic innovations. High-tech systems and materials are resulting in a huge diversity of ground breaking high-tech companies. Therefore, in order to reason the main factors influencing the performance of TTOs, **the representative of TTO within the University of Twente was interviewed**. The opinion expressed regarding the topic is summarized in Table 14, and the full context of it is provided in the interview transcript (see USB storage attached to the study).

Table 14.Comments of interviewee from the TTO at University of Twente on the factors influencing the performance of TTOs.

Group of factors	Factors	Comments of the Interviewee
Economic incentives	Investors	"There're also a lot of investors around."

	Governmental support	“There are some support tools from the government.”
Organization design and structure	Unit of TTO working with students	“So students, if they want to set up a start-up, it's also a different support system.”
	Unit of TTO working with researchers	“So we are really focused on the results for research, and are not involved in any research questions or setting up research projects. It's a different department within this university, so other people working on that.”
	Unit of TTO working with enterprises	“We are taking the results from research and trying to license that to an existing industry or to set up a spin-off company.”
	TTO is a separate holding company	“Yeah. It is part of the university.”
IP strategy and policy	Process management	“I am working fully at TTO – responsible for the IP part as well as managing TTO. I have two lawyers who are also doing the contracts of the University with the industry, but as a part time job they are working for TTO as well. They are responsible for drafting the contracts, establishing spin-offs and doing all legal work for the organization. And then we have business developers who work part-time.”
	Following KPIs	“What I like to have as a KPI is the number of technology transfer contracts that are signed, and it can either be license deal or spin-offs. So I don’t want to optimize on the number of spin-offs or the number of license deals but I want to take it as a total. That’s a KPI for me.”
	IP belongs to university	“The researchers, PhD students, postdocs are also paid by the university in the Netherlands, so they’re just the employees of the university. So all the results from the research is belonging to the university.”
	TTO strategy	“What we have as a strategy is to be the ones who generate impact based on the results of the research.”
Human capital	Period of time worked as an advisor/manager	“If you’re having the right people, the number of years working for TTO is not important.”
	Staff training*	“Within TTO we have entrepreneurs as business developers who we hire part-time (12h/week). It necessary they follow training as provided e.g. by ASTP Proton. For IP/legal we use various trainings which are provided by various external parties.”
	Technical knowledge	“So their interest is not taken by “ou, this is really cool technology”, no. What can you do with it? And that’s also a reason why it's also good not to have a scientist there.”
	Business experience	“At the moment we are having a vacancy for one additional business developer, also for 12 hours, because now we noticed the capacity and we want to generate more output so we need more people who are really the people with the business experience of building the business case.”

	TTO marketing campaign	"Novel-T is organizing events also for industry and sometimes we are part of that, but it's not something that we're really doing ourselves."
	Networking	"If the researcher doesn't want to then you cannot ask him to fill in a business model campus or you cannot ask him to interact with industry to find the right contact or context - then you have to do that yourself as a TTO."
	Marketing campaign for scientific products	"As a TTO we're not necessarily going to international events unless we need to market any of inventions we are having and if it's a good opportunity to find and meet the people."
Industry links	Industry analysis	"And if you have such business developer who each week tries to spend one or two hours in trying to get this running, maybe one day once in a while or maybe some weeks, then it's possible to do that."
	Researchers disclose the inventions	"So people are seeing nice examples. That's the real options of going to industry but at the same time staying in the academic science."
Cultural aspects	Informal relations at the University*	"The informal relations at the university are very important: this is the way to keep in touch with the researchers and secure that nobody 'forgets' that TTO exists."

*Supplemented with additional comments by e-mail.

During the interview it was clarified that *"from the university's perspective, we are just the university's TTO, and the way it's organized is that it's a road to Novel-T because there is also an industry network and they are just as active"*. The interviewee explained that Novel-T is *"more of an ecosystem to stimulate entrepreneurship in this region"*. He also made it clear that **TTO within the University has a very specific task**: *"<...> it's only that part that we are doing within TTO: results owned by the University bringing into the market"*. The interviewee elaborated: *"<...> when the research has been performed and there are certain results, for example, that they [the researchers] have developed a new tip to retain something in the blood, then we are taking the results from the research and trying to license that to an existing industry or to set up a spin-off company"*. However, licensing was started to be done only recently (*"something like four years ago"*) because ***"we are quite a young University <...> we're doing a lot more in spin-offs because it's all new technology, new markets, it's more disruptive"***.

Due to the clear objectives, the system of KPIs is present at TTO of the UT. However, even though *"we're monitoring a number of intakes, a number of patents, a number of spin-offs but the most important for me, and actually it's the only one, that's a number of technology transfer contracts <...> I don't want to optimize on the number of spin-offs or the number of license deals but I want to take it as a total - that's a KPI for me"*. Therefore, the main strategic goal for this TTO is *"that facilitated results from the research are ending up in the market"*. The most importantly, while continuing this topic the interviewee emphasized: *"And* ***if that is via a license deal or via a spin-off company is also not important:***

then we're deciding based on what is giving the best results in the future*"*. Such position explains why technology transfer contracts are taken as one major KPI.

In order to achieve the main goal, TTO at the UT is hiring **business developers** who are *"searching for bridges with industry"*. Their position is based on 12 hours per week, therefore, according to the interviewee, *"it is an honor for them to be in such position, so they have to deliver high quality results and they have to be entrepreneurial next to these 12 hours, meaning, to have their own business for the week"*, otherwise, *"if they're not delivering sufficiently, we can easily cut the contract"*. When asked, if any contract was ever cut, the representative of TTO answered negatively, just mentioned that *"one of our TTO employees left because he had to become a full-time entrepreneur"*. Related to that, he said that when they hired a new person instead of the one who left, *"within couple of months he was fully operational because he's really an entrepreneur, he's really driving for spin-offs"*. Therefore, the interviewee shared an insight: *"**If you're having the right people, the number of years working for TTO is not important.** <...> For me it's much more important that he has experience in setting up his own company and knowing how to do it, knowing how you have to organize a stock, how to survive. Because then they can coach the entrepreneurs in the right way. It's important. And they know how to sell research and that's also important."* Furthermore, he emphasized that **the business developers *"don't have to understand in detail the technology, but they have to understand what you can do with it****"*. He experienced that himself: *"And sometimes when I'm talking to the researchers they really get my interest for the science but I've also learnt that you have to translate it to a product, to a solution and not only look at the technology itself."*

As mentioned before, **the employees of TTO at the UT are seen as a linkage between science and industry**. They conduct the industry analysis and networking by following their daily agenda and at the same time getting involved into technology transfer processes. For instance, there was a case when *"the researcher didn't want to be the CEO of the spin-off company <...> then the business developer <...> found a CEO who was interested <...> managed to get an investor <...> then we integrated everything together: we had the patent, we had the scientific knowledge, we had the CEO, also somebody from the road construction company so he was really an expert in the field <...> the business developer organized all of this".* Such project can be run from one and a half to two years, therefore, the interviewee admitted that "***it takes time, but it's not full time****".* He highlighted that *"if you have such business developer who each week tries to spend one or two hours in trying to get this running, maybe one day once in a while or maybe some weeks, then it's possible to do that".* If it is the opposite case, when the researcher aims to be the CEO of his spin-off, then, according to the interviewee, *"at the beginning the business developers introduce the researcher to industry, help him to learn how to interact with industry, how to find investors <...> then it's more coaching"*.

However, the focus of TTO at the UT is more oriented to *"the researchers about awareness and having the ability to know what we can offer for them"*. The interviewee confirmed that **tight relations**

with the researchers are not less important than the ones with the industry. Even though there are *"some very entrepreneurial professors where everything can go very smooth and automatically"* as well as there are *"some researches that are real researchers and as soon as the business development or commercialization comes into the picture they think it's a sort of some nasty words and they don't want to cooperate"*, the interviewee claimed that they *"focus on the people that are willing to cooperate"* because *"you're not going to force them"*. At the same time, he admitted that they are *"trying to improve the connections, to work together with them a little"*. He also revealed that *"the director of the University - in the 1980s - already started stimulating entrepreneurship"* and thus *"among professors there is some kind of competition: they're seeing that one is having one, two, three spin-offs coming out of their research departments, and other people are having none"*. Moreover, **it is *"also for attracting research money"* because in order to do that *"it's important to have connections with industry"***. However, *"if the researcher doesn't want to, then you cannot ask him to fill in a business model campus or you cannot ask him to interact with industry to find the right contact or context - then you have to do that yourself as a TTO"*. Here is the moment where **TTO needs to be present and *"find the smart ways to organize that"* because *"the knowledge is central"***.

To continue, during the interview it was explained that TTO work is supported by the governmental tools as much as by the private investments. For example, *"there is a funding agency that's providing what they call 'valorization grants' or 'take off grants', and that really helps to bridge the gap between the market and the results from the research"*. The interviewee was glad to illustrate the latter support by saying that "*there were five applications which got into phase for getting the loan – 250 thousand euro each, so we were able to attract 1-million-euro loan for spin-off companies to Twente University"*. Besides that, he explained that *"Novel-T invested a lot of time the last couple of years in setting up good investment ecosystem"*. He revealed that *"**there are quite some investors here that are also willing to invest in an early stage**"*. Furthermore, *"sometimes they're really willing to invest in technology even if it has no application yet"* because *"**if they are already having the right network, then the possibilities to develop and apply the technology are big and they are willing to take a risk**"*.

To sum up, during the interview several main factors influencing the performance of TTO at the UT were reasoned. First of all, the exclusive focus on the technology transfer as a result regardless the shape of it. Secondly, the importance of employing business developers who have entrepreneurial mindsets and experience in business because they are the link to industry. Thirdly, the significance of relations with the researchers who sometimes need to be guided and coached by TTO. Lastly, regional focus and cooperation on the technology transfer which is crucial.

TTO at the University of Aveiro (UATEC)

According to Regional Innovation Scoreboard 2017, Portugal belongs to the group of Moderate Innovators which perform from 50 % to 90 % of EU average. Based on RIO Country Report 2017, innovation performance and academia-industry cooperation is very low in Portugal because the majority of companies operating there are medium-low and low-tech. Therefore, there are governmental intentions to improve innovation performance by strengthening technological and managerial capabilities within the firms as well as to stimulate knowledge intensive activities at the new companies. Meanwhile, according to the Global Innovation Index 2017, improving changes in R&I sector are visible related to increasingly growing number of high-skilled human capital and international scientific co-publication.

University of Aveiro (UA) is an entrepreneurial and innovative university based in Portugal. The aim of this University is to increase the cross-sectoral collaboration and to convert knowledge into economic value. UA has a department called Technology Transfer Unit (UATEC) which together with University of Aveiro Business Incubator (IEUA) assists in developing ideas for innovative products and services in order to contribute to the society, in other words, it serves as technology transfer office. University is also a part of the University Technology Enterprise Network (UTEN) launched in 2007 by the IC Institute at The University of Texas at Austin in a collaboration with the Council of Rectors of Portuguese Universities and the Portuguese Industrial Property Institute, and sponsored by Portuguese Science and Technology Foundation. The goal of this network is to commercialize science and technologies created by Portuguese researchers and to stimulate international joint projects, as well as to strengthen innovation ecosystem in Portugal. Therefore, **an interview with the representative of Technology Transfer Unit at University of Aveiro was conducted** in order to indicate the factors influencing the performance of TTOs. The opinion expressed regarding the topic is summarized in Table 15, and the full context of it is provided in the interview transcript (see USB storage attached to the study).

Table 15. Comments of the interviewees from UATEC on the factors influencing the performance of TTOs.

Group of Factors	Factors	Comments of the Interviewees
Economic incentives	Investors	"We have business angels, venture capitals who can invest in the new results that came from university and from our lab."

	Governmental support	“Ir order to finance our activities as the TTO we have the national programs that are based of course mainly on European finances.”
Organization design and structure	Unit of TTO working with students	“Yes.” “We also provide the service in these four different areas.”
	Unit of TTO working with researchers	
	Unit of TTO working with enterprises	
	TTO is a separate holding company	“We belong to the university.”
IP strategy and policy	Process management*	“We have four people within departments: one in Intellectual property management, one in the Licensing, one in Entrepreneurship and one in Industrial liaison.”
	Following KPIs	Comments were not made.
	IP belongs to university	“To the University.”
	TTO strategy	“I follow my strategy. <...> University sometimes can not have a strategy for this.”
Human Capital	Period of time worked as an advisor/manager	“<...> a girl, she had degree in language. I trained her to be working with IP and after she became official attorney.”
	Staff training	“So there are people who have a strong knowledge in some of these areas, for example, now with me is Eva and she is a senior project manager <...> Eva does training with Joana in different areas related to entrepreneurship.”
	Technical knowledge	“Working at the TTO I always try to have people with different backgrounds.”
	Business experience	
Industry links	TTO marketing campaign	“What we want to promote are the relations between people, on the both sides we have people.”
	Networking	“<...> we promote many events that are networking events, that are innovation club events, that are more mentoring events.”
	Marketing campaign for scientific products	“<...> we have these different platforms to give the possibility or to promote the collaboration between university and companies in more specific fields.”

	Industry analysis	"Normally we will bring on the table a new subject, new thematic, things that not even good professors or industries completely know. So they have to interact with each other. In addition, they should learn from each other."
Cultural aspects	Researchers disclose the inventions	"<...> the provisional patent application <...> We have as it is in the United States."
	Informal relations at the University	"We tried to gather together the people, the researchers, the faculty members as well as the students."

*****Supplemented with additional comments by e-mail.

To begin with, during the interview with the representative from UATEC it was identified that the University is *"an organic institution which is related to and depending on rector's' office"* as well as the fact that *"everything comes from the university".* It means that TTO is directly dependent on the University. It follows the fact that the IP belongs to the University: *"IP rights should be interpreted directly to labor law."* In other words, the researcher is using the resources, infrastructure and other facilities of the University in order to create his or her invention, and without these facilities and conditions there probably would be no invention. In the case of commercialization, the researcher and the university gets equal part of the profit: *"50 percent of them are going to the inventors or to the faculty members or students <...> and the other 50 percent stay at the University".* However, the representative expressed his opposite personal position regarding the IP rights related to students. According to him, if the students develop an invention without researcher's supervision and university's resources (such as laboratories and classrooms), the IP rights should belong to the student. Representative's position stands for stimulating the students to be more open and share their ideas, for encouraging their development regardless the fact if the startup is developed at the university or outside. **The most importantly in this situation is that the result would be implemented in the society.**

While providing services for all members of the University of Aveiro, UATEC is composed of four different interrelated functional areas: 1) Intellectual Property Management focuses on management, prosecution and information dissemination activities for intangible assets, namely patents, trademarks, utility models, design and copyright which are applied both on national and international levels; 2) Licensing aims to bring technologies with IP and commercial value into the marketplace via exclusive or non-exclusive licensing agreements; 3) Entrepreneurship area fosters entrepreneurship through four groups of activity: business development, capital sourcing, mobility and training; 4) Industrial Liaison area aims to promote and maintain the university-industry connection. Moreover, the interviewee mentioned that this TTO also has "*platforms that aggregates researchers, teachers, and technicians from different departments who can support and give answer to society as well as cover*

company's needs." Platforms are the instruments to promote the cross-sectoral collaboration, as well as to provide detailed and specific information on particular services that are performed by the researchers.

The mentioned interrelated functional areas and platforms would not be operating without the employees of UATEC. As TTO is an intermediate between the University and industry, the staff of TTO plays an essential role in performing this function successfully. By saying "*the idea is that we should all look how you can add value for the knowledge which already exists*" the interviewee distinguished the diversity of the team as a priority. In other words, **people with diverse backgrounds can create value by using their knowledge in a different perspective and in such a way provide the team with additional, unknown insights which can influence a start of the new processes and actions followed by more effectiveness and efficiency**: *"Working at TTO I always try to have people with different backgrounds and sometimes I do some crazy things. <...> Therefore, in the end we have funny results."* The representative of TTO complemented this conclusion by providing an example from the existing practise: "*I remember there was a girl who had a degree in language. I trained her to work with IP, and after she became an official attorney*". Such instance also reveals that **it is important to invest time and resources as well as to share the knowledge existing within the organization in order to improve skills of the staff**. Additionally, people have to understand what they are capable of and what needs to be done in order to create value to the organization.

Moreover, during the interview it was revealed that **emotional intellect of the employees is as much valuable as the knowledge and capabilities**. According to the interviewee, there is firmly entrenched image about the researchers who are not capable to work with the industry because of the certain personal attitude, and vice-versa - about the business people who are focusing only on how to generate more profit and not going into contact with the science. Therefore, in order to destroy this stereotype, it is crucial to emphasize the relations among people. According to the interviewee, **if the representatives from opposite sides of different sectors were more flexible and trusting each other, the cooperation process would be more successful**: *"The key point of the relations between the University and the companies is confidentiality."* As a result of such approach, open communication stimulated the community of the University of Aveiro and the region around to significant changes: *"However, in the last two years we see huge, huge difference, huge mentality change, huge behavior changes at the University as well as at the companies".*

To continue, **human factor acts an important role in the technology transfer process**: *"What we want is to promote the relations among people because we have people on both sides".* In order to achieve this, UATEC is actively participating in organizational processes: *"We try to gather all people: the researchers, the faculty members, the students as well as the entrepreneurs and the companies. So we try to organize different events where we promote these kind of actions, and in at the same time destroy the mindset which some of them could have".* Moreover, the interviewee believes that *"among*

1000 professors if 10 percent of them work with companies, it is a great result <...> not spread our energy in everything". **It is critical to acknowledge the fact that some of the researchers will not work with the companies anyway**, even though *"their results are evaluated not only in teaching and in research but also in technology transfer and in management".*

Financial support was mentioned as one more essential element for work of TTO:*"The major impact factor is the money and who controls them".* **Financial advantage empowers relevant actors to start new projects, to develop researches, to initiate the implementation of new ideas, etc. Without the financial investment the inventions cannot be developed.** Therefore, for such matter additional governmental support and international projects are the way to extend the budget of TTO (*"we have Iberian projects that are only financed for Portugal and Spain, and then we also have another one which is financed by the Portuguese, Spanish and French entities", "besides that we also have several projects related to ERASMUS +, instruments for SMEs").* However, even though the universities are the institutions which are expected to invest in R&D, according to the data provided by the representative *"in 2017 the entities that invested more in research and development in Portugal were the companies".* It demonstrates good progress because "*companies are doing effort on research and development departments <...> I think, huge effort is done by the companies in order to have this kind of activities."*

To add, in order to stimulate the action in the innovation ecosystem and to achieve sustainable results beside appropriate financing it is also important to have a strategy. Even though when asked about the latter the interviewee said *"I follow my strategy"*, he admitted that TTO cannot act separately from the University but also confirmed that *"the University cannot have a strategy for this sometimes"*. Thus, **it is the people working within the organization who know the best how to perform on the activities related to TTO, and therefore they create the strategic orientation in order to reach the goals**.

To sum up, during the interview several main factors influencing the performance of TTO at the UA were reasoned. First of all, the relations among people based on respect and trust motivate researchers and companies to get in contact for the cross-sectoral collaboration. Secondly, it is relevant for TTO to work just with those researchers who are motivated and willing to collaborate with the industries. Lastly, diversity of the competencies and experiences in every aspect of the activities of TTO creates additional value and new opportunities for TTO to function successfully.

TTO at Tampere University of Technology (Innovation Services)

According to the Global Innovation Index 2017, Finland is ranked in the 8th place. It is among the top 5 performers in institutions as well as health and primary education (1st), higher education and training (2nd), innovation (4th). It scores the lowest in market size (60th) macroeconomic environment (33rd), labour market efficiency (23rd) and – due to indexes like fixed-telephone lines per population - infrastructure (26th) (RIO Country Report Finland 2017). Meanwhile, according to the European Innovation Scoreboard 2017, Finland is at the 4th place and is called one of the Innovation Leaders. It is estimated that public and business R&D expenditures are significantly above the EU average (140.9 and 164.4 scores comparing to 98.2 and 109.4 respectively) in this country.

Tampere University of Technology (TUT) is one of the important actors in the whole innovation ecosystem in Finland. Established in 1965 as a subsidiary of Helsinki University of Technology, in 1972 TUT gained independence and in 2010 it started operating in the form of a foundation. At the moment TUT is in the process of joining forces together with the University of Tampere and Tampere University of Applied Sciences. By benefitting from multidisciplinary interactions and drawing interest on higher impact in both Finland and internationally, this process, called *Tampere3*, aims to establish an inspiring and globally attractive environment for research and learning. According to QS World University Ranking, with almost 6000 students and 705 academic staff members TUT is number 380.

Tampere University of Technology does not have fully functioning technology transfer office. However, such functions are performed by the department within TUT called the **Innovation Services**. The purpose of this unit, among others, is to assist in transferring the knowledge, created by the University's researchers, to the market. Therefore, in order to identify the factors influencing the performance of TTOs **the representative of the Innovation Services at TUT was interviewed**. The opinion expressed regarding the topic is summarized in Table 16, and the full context of it is provided in the interview transcript (see USB storage attached to the study).

Table 16. Comments of the interviewee from Innovation Services on the factors influencing the performance of TTOs.

Group if Factors	Factors	Comments of the Interviewee
Economic incentives	Investors	"20 venture capital investors with which we regularly collaborate."
	Governmental support	"And then other possible incomes could be projects, governmental development projects."

Organization design and structure	Unit of TTO working with students	"Then I have three, well, no, two students, research assistants who focus on supporting the students."
	Unit of TTO working with researchers	"Tamlink works as a holding company for our spin-offs so at the moment they have 17 or 18 spin-offs in their portfolio."
	Unit of TTO working with enterprises	"We have around two to three hundred new projects with the companies every year. And total project portfolio at the university is around 500 which is active around the year."
	TTO is a separate holding company	"We don't have something what we could now call the TT office. Innovation Services which I'm heading is a TT office also, however, it's not only for technology transfer purposes."
IP strategy and policy	Process management	"At the moment I have couple of innovation officers and another one is on the recruitment process. <...> Then I have a coordinator there who takes care of practical things, meaning, all the paperwork. Then I have one person who is focusing on impact things, meaning, supporting the creation of the research projects in early stages. <...> Then I have <...> two students, research assistants who focus on supporting the students. <...> And then in addition I have one person there who is irresponsible to manage Demola."
	Following KPIs	"We have KPIs – yes, but we don't have KPIs to reach."
	IP belongs to university	"No, they don't, of course, - we take the rights."
	TTO strategy	"We have a better ways or more creative ways to work in some cases, but we select them and also define that why we're doing that and doing really well."
Human Capital	Period of time worked as an advisor/manager	"It depends on the person totally how he utilizes or she utilizes, skills, networks, et cetera. It's totally personal dependent."
	Staff training	Comments were not made.
	Technical knowledge	"They have been involved with business technology transfers, all are master science level minimum."
	Business experience	"<...> really business development oriented <…>"
Industry links	TTO marketing campaign	"<...> one conference where my team is going to participate is this University Industry Interaction Conference in London."
	Networking	"So in the end you need to cooperate with the companies also." "And then we have several focused workshops or events which we work on with companies or investors on local city or region or something like that."

	Marketing campaign for scientific products	Comments were not made.
	Industry analysis	Comments were not made.
Cultural aspects	Researchers disclose the inventions	"The new professors whom we're getting are more and more about this industrial collaboration and working with networks, et cetera."
	Informal relations at the University	"So sometimes we are involved, sometimes we are not - it's not systematic, to be honest. It depends on how well we know our researchers, on how well we more or less go and hold their hands." "<...> one very extremely good professor was totally against TTO when I came, and now he is totally favoring it."

During the interview the representative of the Innovation Services revealed that investments from the private funding, aiming to strengthen function of TTO, are more common practice than the governmental support. When asked, if TTO has a possibility to apply for the governmental funding, for instance, in order to expand the office human capital wise, the interviewee expressed the position as follows: *"We have that possibility, however, I try to avoid it. Because this kind of external funding is project based, and I'm only using that external funding for the development purposes and not to expand our operations. My position is that we need to get the money from the university which needs to invest for our growth. If they are not doing that, it responds that we're not important in the picture of the university. As for short-term hiring and extension of the office, I've heard only bad experiences from the other universities."* Such attitude sends a clear message that **the University itself has to take a stand regarding the existence of TTO and accordingly invest into related processes**.

The representative of TTO at TUT indicated that they *"have KPIs <...> but we don't have KPIs to reach"*. Instead, he specified: *"We set certain targets for us. <...> for example, <...> spin-offs, commercialization projects <...>, commercialization initiatives which we are preparing to get funded, startups based on university's research or know-how from both - personnel and students".* Setting certain aims implies strategic planning which is important for TTO to follow. As the achievements of TTO, among others, are dependent on the productivity of the researchers, the IP ownership is a subject matter. At TUT the IP does not belong to the researchers: *"<...> we take the rights. They are the inventors and they need to sign on the papers"*. However, the interviewee revealed that *"we don't aim to develop any patent portfolio at the university because we don't have clear plan how to monetize it"*. He explains this situation as follows: *"So if you're investing to patent portfolio then you also need to see how you are going to benefit from that. If you don't have that idea in there, then you shouldn't check that. And if we would like to have patent portfolio, then we should also invest on managing patent portfolio and on developing it further, and also operating commercially in order to work with the*

industrial partners there. So we patent only when we have a way to commercially monetize, I would say, between one to three years. If we don't have that then we don't talk about it". Therefore, **it is essential for TTO to have a clear knowledge about its prioritized areas and the measures to achieve its goals**.

To continue, during the interview it turned out that the Innovation Services covers all the actors which are traditionally involved into the knowledge transfer processes: researchers, students and companies. And even though *"all TTO activities are managed by my team"*, TTO of TUT is closely cooperating with the other players in this ecosystem: *"Tamlink is managing some of our university's research collaboration projects"*, *"agency which is aiming to support the establishment of new companies – really practical things"*, *"the innovation funding agency <...> work in our premises maybe one or two days per week <...> they support our research and also other companies"*, "*partnering with one bank – Nordea bank, and another national investor"*. This reveals the importance of networking, and especially - the link between academia and industry. For such matter a hub of science, research and technology Kampusareena was mentioned during the interview: *"So, for example, this is in the middle of our campus and it is bringing companies, researchers and students together. So this is one way of doing business interface. And we as a TTO are a part of that, especially when it is related to IP management, but also developing this relationship."* Another example of business-academia collaboration in Tampere is Innoevent: *"It was last November and there were 800 students there solving companies' problems for one week. <...> the number of companies involved probably around 10 to 20 – both English and Finnish."* This kind of events are also an arena for TTO to promote its function and get into closer contact with the relevant performers in the field of innovation and entrepreneurship. As the interviewee revealed, *"typically, **I'm ready to invest in something that adds value to our university, to our TTO function or to the mission of commercialization**"*.

Moreover, in order to build the bridge between science and business, relevant professionals are needed. Even though the head of the Innovation Services has a strong business background, there are people with various experiences working in this TTO at the moment. However, when the interviewee was asked, if he agrees with the statement which suggests that if an employee has a strong business background, the period of time worked at TTO is not important, he could not generalize that because *"it depends on the person totally how he or she utilizes skills, networks, etc."*. However, he admitted that *"**TTO people are or need to be such persons who are really cooperative, really connected, really business development oriented, really capable to combine things, because in the faculties and the laboratories they work in silos, and at TTO things are combined and you need to see different views because then once, twice, three times per week we see that: hey, by the way, do you know that this and that is done there**".* Thus, the characteristics named by the interviewee are applicable to the persons who have experience or close relation to business.

Furthermore, close contact with the industry is as much important as informal relations with the closest environment - the researchers and the students. Even **the results of the produced work sometimes depend on the fact if TTO is involved in the process or not**: *"However, whenever you publish something and you would like, for example, to ensure that there is a chance, for example, to protect some IP, then we get involved. So sometimes we are involved, sometimes we are not - it's not systematic, to be honest. It depends on how well we know our researchers, on how well we more or less go and hold their hands."* Therefore, **in order to reach the positive results for all involved parties, the recognition must be achieved**: *"<...> we really need to go next to the researchers and say that the research is important and that it's also important that we ensure the industrial rights on the creation of your new results. And so it's constant hand holding, changing people, forcing people to change their minds. We have very good examples here too. For example, one very extremely good professor was totally against TTO when I came, and now he is totally favoring it. So he's one of the key examples there who managed to combine the research work and the deployment of the research work, and then utilizing the research work."* **The process of acknowledgement is an important element in the daily work of TTO**. As the interviewee named, *"**it's a cultural transition <...> which might take 10 to 20 year**s"*. However, in the eyes of the representative of the Innovation Services, **the change is unavoidable, and there is an explanation for that**: *"So here is the research work which is money - euro, dollars or whatever. So where does it come from? It comes either from taxes or companies but I would say that taxes are the source because public funding is based on taxes <...> So where does the tax come from? The tax comes from the companies, people, etc. So this is research, this is the result [pointing at his whiteboard]. The results need to go to the companies in order to create business, in order to create taxes and in order to fund. And of course if companies fund themselves they need to have money which are based on the results. So in the end you need to cooperate with the companies also. And people are doing this but they don't admit that. And it's not only technical area but also humanistic area. In the end taxes need to be paid because if you create such results which you cannot benefit from societally or business wise, then why you would do that, why somebody would fund you".* Therefore, the interviewee is sure that *"the researchers in the end are the entrepreneurs, they are the entrepreneurs of their research work, they actually seek funding for IP."*

To sum up, during the interview several factors influencing the performance of TTO at TUT were reasoned. First of all, the importance of the strategic focus of TTO and clear knowledge about capacity of it. Secondly, the ability to understand the mindset of the ones involved in the technology transfer process and use that in setting up the appropriate relation in order to shape it in a way which is more eligible. Thirdly, the necessity of staff at TTO who are oriented to business development, in other words, capable of "connecting the dots". And lastly, the significant internal need of TTO presence at the University and region.

TTO of Hamburg University of Technology (Tutech Innovation GmbH)

Germany is the largest country within the European Union in terms of population (81.2 million inhabitants in 2016) and gross domestic product (GDP) (€ 3,263 billion in 2017) (RIO Country Report Germany 2017). On the European Innovation Scoreboard Germany is among the countries called *Innovation Leaders* and is ranked after Switzerland, Sweden, Denmark, Finland, the Netherlands and the UK. Private co-funding of public R&D expenditures is evaluated as highly performed in Germany comparing to EU average (177.9 and 98.7 points respectively). For comparison, according to the Global Innovation Index 2017, Germany is ranked in the 9th place. The Index indicates that Germany is a leader in patent applications by origin as well as has advantages in business R&D expenditures. Meantime, a low share of foreign doctorate students, lack of venture capital and employment in fast growing companies urge relative weaknesses.

Hamburg University of Technology (TUHH) adds value to German economy by producing knowledge. Even though the plans for a university of technology in the Süderelbe area of Hamburg go back to the 1920s, only in 1978 TUHH was found aiming to promote structural change in the region. In 2015 TUHH concluded cooperation agreement with DESY which is one of the world's leading accelerator centres. Such collaboration, among others, enables TUHH to strive for its mission more effectively, meaning, to be a competitive entrepreneurial university focusing on high-level performance and high quality standards (TUHH, 2018). According to QS World University Ranking, Hamburg University of Technology shares 201-250 place.

As TUHH is aiming to develop technology for people, research, teaching and technology transfer are the main measures for such a goal. The latter one is significantly emphasized in the surroundings of TUHH, and therefore, the University established two holding companies - **Tutech Innovation GmbH** and **Hamburg Innovation GmbH** - which act as the technology transfer offices. They both provide full technology transfer services for Hamburg's universities and Research institutions. However, the difference is that Tutech Innovation is 51 % owned by TUHH and 49 % - by Free and Hanseatic City of Hamburg, meanwhile Hamburg Innovation has 9 shareholders and one of them is Tutech, the other 8 - various education institutions operating in the City of Hamburg. Thus, in order to identify the factors influencing the performance of TTOs, **the representative of Tutech Innovation and Hamburg Innovation was interviewed**. The opinion expressed regarding the topic is summarized in Table 17, and the full context of it is provided in the interview transcript (see USB storage attached to the study).

Table 17. Comments of the interviewee from Tutech Innovation GmbH on the factors influencing the performance of TTOs.

Group of Factors	Factors	Comments of the Interviewee
Economic incentives	Investors	"We have more or less exclusively the private funding."
	Governmental support	"All the public funding is running through the university itself because as a company we are not able to get the right funding levels."
Organization design and structure	Unit of TTO working with students	"There are four business units. One is research management, the second one is IP management, the third one is start-up management and the fourth is consultancy and we call it competence development."
	Unit of TTO working with researchers	
	Unit of TTO working with enterprises	
	TTO is a separate holding company	"I'm running two companies: TuTech Innovation and Hamburg Innovation. <..> TuTech is owned 51 percent by the Technical University of Hamburg and 49 percent by the city of Hamburg. So it is a pure public company, but with a private mission."
IP strategy and policy	Process management	"We have a managing board consisting of four people. There are four business units. <...> And then of course as a user company we have marketing and sales where we have human resources, finance and IT. So that's the back office part. It's very important because you have to act professional."
	Following KPIs	"We have a great broad set-up of KPIs."
	IP belongs to university	"So there is a law which was changed in 2002 when they took the rights away from the professors and gave it to the employer. So now the universities are the owners of all the IP."
	TTO strategy	"This is our business model as well. This is where we are gaining money."
Human capital	Period of time worked as an advisor/manager	Comments were not made.
	Staff training	Comments were not made.
	Technical knowledge	"So we are now in the 25th year of our operation. And I think it is why after my predecessor was off the desk and gone - retired, the university was really looking for a CEO which had business experience or actually both."

	Business experience	“I think so - absolutely important." (referring to the need of business background for the employees of TTO)
Industry links	TTO marketing campaign	“We've done a serious restructuring program the past three years and by this time we stopped all marketing topics and now we are starting to market again.”
	Networking	“We are approaching the enterprises, the professors do, and the enterprises also approach us. So from each of these three sides.”
	Marketing campaign for scientific products	Comments were not made.
	Industry analysis	“And we as their company are in charge of looking and commercializing such things and also analyze which make sense and which not - validation process.”
Cultural aspects	Researchers disclose the inventions	“This is a pretty good chance for them to get hired, and also they have the possibility to get projects quite quickly.”
	Informal relations at the University	Comments were not made.

The interviewee revealed that Tutech Innovation *“is the oldest technology transfer company in Germany”*, also commenting that *“Hamburg University of Technology is a little bit different because they were thinking technology transfer from the very beginning when they have been found in the middle seventies”* which *“was very untypical to German universities”*. As for the structural matter, established 25 years ago, this TTO is set up separately from the University as a holding company, structured in a way that all relevant stakeholders - researchers, students and companies - are involved into the knowledge transfer process: *“There are four business units. One is research management, the second one is IP management, the third one is start-up management and the fourth is consultancy and we call it competence development.*” Additionally to that, *“as a user company we have marketing and sales where we have human resources, finance and IT”* which is essential *“because you have to act professional”* in *“a pure public company <...> with a private mission”*. Thus, picturing TTO in such a light sends a signal that **clear structure and comprehensive inclusion of related stakeholders are significantly important for the organizations managing technology transfers**.

While talking about financing, the interviewee told that as Tutech Innovation is operating equally to any private company, the governmental support is limited: *“For instance, when it comes to Horizon 2020, a company like us gets just 70 percent of the funding in the research and innovation actions, and we have to contribute 30 percent on our own”*. Therefore, *“all the public funding is running through the university itself”* and *“the majority of our research is financed from the small and medium enterprises,*

but also large global players". As it was expressed by the representative of Tutech Innovation, the companies *"are approaching us, asking for expertise and then they are paying for the research"*.

Continuing the subject about the **link with the industry**, the interviewee admitted that it **is critical because *"this is our business model as well - this is where we are gaining money"***. When asked, if the companies come to TTO or the latter is more approaching the enterprises, the interviewee confirmed that *"it's both"*. However, he also expressed a concern *"we need to be more active"* explaining that *"I'm currently building up a scouting system just to identify what research results in the universities can be transferred to the market and then how we can approach the enterprises more actively than before"*. He also mentioned that *"we've done a serious restructuring program the past three years and by this time we stopped all marketing topics and now we are starting to market again"*. This kind of approach identifies that **even though Tutech Innovation is already recognized by the industry and gets financed by the global companies, it is critical to continue improving the connection and delivering high results**.

When asked if reaching out to the industry depends more on the employees of TTO or the strategy, the interviewee admitted that **supreme achievements cannot be reached without both - ambitious personnel and strategic approach**. He agreed that **business experience is significantly important for the staff of TTO**: *"<...> if you've never run a company or if you have no experience with economics, it's very difficult to be a good consultant <...>".* Moreover, as restructuring process at Tutech Innovation is present, the current aim is to *"try to have an internal change **management to become more entrepreneurial, also for the team members to have more responsibility so that they can get on a new attitude in getting more contracts and things like that**"*. However, considering all that the interviewee also emphasized that **technology transfer as a function *"is not a simple sales approach"***. He explained that *"**it's more than this because we are at the bridge between business and science and we have to take care of both sides** and of course we cannot convert ourselves to a hard selling company - that's not our task"*. As for the strategy, at TTO of TUHH it is implemented through *"a great broad set-up of KPIs <...> which is necessary"*. The interviewee also shared an insight that this type of operation *"**is also good for the City of Hamburg because it contributes to their economy**"*. This is because, as it was mentioned before, Tutech Innovation is partially owned by the City of Hamburg which *"is really rather rare <...> is also not typical for Germany"*.

Regarding the IP in Germany, the interviewee explained that *"there is a law which was changed in 2002 when they took the rights away from the professors and gave it to the employer so now the universities are the owners of all the IP"*. Therefore, in the representative's opinion, TTO is *"in charge of looking and commercializing [innovations] and also analyzing which make sense and which not - validation process"*. And the researchers *"like it very much"* because *"this is a pretty good chance for them to get hired, and also they have the possibility to get projects quite quickly"*. The interviewee

explained: *"You have projects which are terminated, let's say, they run for two years, and they are looking forward to get another one, but there's a break of three months, so there's no chance to be employed by the university for these three months, but we offer the possibility. So it's also a clear way of being employed as a way of bridging such gaps <...>"*. However, Hamburg University of Technology is rather an exception in such reaction towards TTO because in big and not so technology-focused universities in Germany *"part of the professors are really not interested at all to work with any member which is a player in the markets: they just want to do their basic research and that's it"*. Therefore, **various tools are taken into action** (*"scouting system <...> to identify the kind of low hanging fruits"*, *"success stories to make an example"*) **in order to boost the entrepreneurial culture within the researchers**. Opposite from the latter, cooperating on the researches with academia *"is something German companies learned very quickly"* because *"you have certain possibilities you can do with your research team within the companies and then there are other things you can't do: you don't have the expertise or you don't have the money because your return on investments doesn't count right and your controller says: "No, you're not going to get the money."* Thus, finally, **it is a matter of *"the mindset what we have"***.

To sum up, during the interview several factors influencing the performance of TTO at TUH were reasoned. First of all, the essentiality of the involvement and interest of the city in knowledge transfer processes. Secondly, the importance of constantly boosting the entrepreneurial mindset as well as creating ties among the actors involved in technology transfer. Thirdly, clear understanding about the fact that TTO is in a position of an intermediate between academia and industry, and therefore, TTO needs to serve both sides at its best. Fourthly, an undoubted need for the employees of TTO to have business experience. Lastly, the significance of clear TTO structure and strategic focus.

TTO at Aalborg University

Denmark belongs to the group of Innovation Leaders in Europe together with Sweden, the Netherlands, Finland and Germany. There is a strong and friendly innovation environment, attractive research system and human resources in Denmark. However, sales, innovators and employment impacts are the weaknesses of this country (European Innovation Scoreboard, 2017). According to Global Innovation Index 2017, the country takes 6th place out of 127 countries in the world. Stable public finances and positive balance of payments as well as low unemployment rate, low inflation and high R&D intensity in the country enable innovation ecosystem operate effectively and efficiently. Despite the fact that Denmark is among the Innovation Leaders, there is still a potential to increase innovation performance within the country, especially in SMEs. Furthermore, there is a need to stimulate innovation

actors to interact in order to improve the commercialization of the research as well as to increase the quality of the research performed in the country (RIO Country Report: Denmark, 2017). Therefore, a new comprehensive R&I strategy "Denmark - Ready for the Future" was launched with the priorities to increase quality and societal impact of R&D. However, there is no one common smart specialization strategy in Denmark. Instead, there is a collection of governmental and regional growth plans and development strategies.

Funding infrastructure for R&I is well established and organized in Denmark. Ministry of Higher Education and Science is the main actor responsible for R&I financial support. Moreover, the eight universities and Danish University hospitals are the main performers of public R&D. According to Statistics Denmark (2015), around 44 proc. of all companies perform R&D activities.

Aalborg University (AAU) in Denmark is one out of eight universities which are actively involved in the innovation ecosystem. AAU is in the top 2 percent of the worlds' 17 000 universities, although it has been preparing students with excellent academic knowledge just since 1974. AAU is actively involved in local, regional and national development, thus over the past three years its income increased by 50 percent from the cooperation with external partners. TTO, established in AAU, assists researchers to collaborate with business in order to create new ideas, participate in joint projects or to commercialize the inventions created by academia. Therefore, in order to identify the factors influencing the performance of TTOs, **the representatives of TTO at Aalborg University were interviewed**. The opinions expressed regarding the topic is summarized in Table 18, and the full context of it is provided in the interview transcript (see USB storage attached to the study).

Table 18. Comments of the interviewees from the TTO at Aalborg University on the factors influencing the performance of TTOs.

Group of Factors	Factors	Comments of the Interviewees
Economic incentives	Investors	"We have received financing for a four year period from a private fund."
	Governmental support	Comments were not made.
Organization design and structure	Unit of TTO working with students	"Regarding commercialization for students. We have a separate department. They are sitting five meters from us."
	Unit of TTO working with researchers	"We have two people doing traditional TTO function."
	Unit of TTO working with enterprises	"The university interacts the most with the industry already, but we want to do even more if we have some energy."

	TTO is a separate holding company	"We are part of the university.."
IP strategy and policy	Process management	"<...> we have two people doing traditional TTO function <...> Then we have two people doing the project that we have received financing for a four-year period from a private fund. <...> The rest is just the administrative help and me. We have access to our legal department as well."
	Following KPIs	"I do not know if we use."
	IP belongs to university	"We can acquire the rights to IP that employees produce, but it is something we have to do actively."
	TTO strategy	"Not really because the University's strategy incorporates this so there is no real need to have a separate strategy. We do have some tactical strategies."
Human Capital	Period of time worked as an advisor/manager	Comments were not made.
	Staff training	"We do not put them through education: you learn from your colleagues - in that way."
	Technical knowledge	"People have different backgrounds. We really see that as a force that we have a mix of people there, whether in engineering backgrounds or economic backgrounds. It is a good way to approach new technologies and see what and how they can be used and commercialized."
	Business experience	
Industry links	TTO marketing campaign	Comments were not made.
	Networking	"We go to the Danish IP fair. <...> We invite all the business and network people we have. It's actually an opportunity to show up."
	Marketing campaign for scientific products	"<...> is a network showcase of all technologies. Hundreds of technologies from all universities in Denmark."
	Industry analysis	"We know the value proposition from companies. We also know the research value proposition and try to balance those two and try to find the ways of seeing the world."
Cultural aspects	Researchers disclose the inventions	"An employee is required by contract law to disclose the invention. If you think you have made an invention you are required to disclose that to TTO department."
	Informal relations at the	"Therefore, a relation-based network is what we like a lot."

	University	

During the interview it was explained that TTO at AAU is within the university. According to the interviewees, they operate as a traditional TTO. The latter does not generate any profit because *"most of the income comes from having a consultancy company and not from TTO activity".* For that reason, Aalborg University has *"an external, a shareholder company that is hundred percent own by the University"*. The interviewees explained: *"**It is not the way technology transfer works. It is not a direct money business. Yes, you can have some successful cases. However, it is not a business that you can keep cash rolling into the University.**"* It is more important to *"bring out those technologies to the companies in a commercial way for them to use them"* because while being *"focused on becoming good at bringing out technologies <...> in the end they will be making money as well."* The representatives revealed that they "*typically are not that principled in achieving a deal <...> **we are not organized to get the highest price**".* **The whole technology transfer process has more added value than only the revenues**: *"It shows a very small part of the picture, of the income picture, because how can you put value if an employee or a researcher discloses an invention to us".* Unfortunately, not every involved party is able to recognize and understand that: *"<...> people in ministry have a very simplistic picture of the reality".* This position reflects that **behind the numbers and contracts there are cultural aspects which are fundamental in order for TTO to perform successfully because trust and understanding has a positive influence on the performance of TTOs**.

In order for technology transfer to happen, relevant professionals are needed. Based on the experience of the representatives (*"so you really have the economic guys here <...> I have industrial background in corporate accounting")* it can be claimed that **economic background is a one of the priorities for working at TTO**. It is this way because *"sometimes we have a technology which can be seen from different perspectives, for example, either from a medical perspective or from an economic perspective."* Economic competence is needed in order to be able to evaluate the financial aspects of the technologies before bringing them out to the market. While talking about the competencies it was also found out that **only a combination of skills leads to successful performance of TTO**: *"It is not really a simple question because you cannot educate yourself to become a TTO <...> Therefore, you really need many competencies".* To add, according to the interviewees, the profile of the employees working at TTO is a very debatable aspect. **Just by combining different experiences in certain period of time and mentoring constantly you can become a good technology transfer specialist** (*"we do not put them through an education <...> you learn from your colleagues in that", "if you have a new person, the way to develop skills is of course by having all these discussions over the years").* The time and experience of the staff is directly linked to the activities and processes at TTO: *"There is nothing that is worth a million just on face value, so **you need to work with this**. You need to work with maturing the*

technologies through the scientific research group <...> Therefore, a lot of work needs to be done in order to develop in this field".

During the interview it was also revealed that *"an employee is required to disclose the invention by contract law".* **By stimulating the researchers to reveal their ideas TTO allows them to decide if they want to commercialize the invention with the help of the University or they wish to do that by themselves.** After the evaluation of the potential of the invention the University can require intellectual property rights to it. By doing that TTO commits to be active in finding the ways to commercialize the invention and to gain revenues from it: *"We do not acquire the rights and then put them into a drawer - we need to do something actively".* In case of the success the researcher and the University receives revenues. If the University do not require the IP rights but the researcher manages to commercialize the invention, the University still gets certain part of revenues. Therefore, the collaboration within the organization is encouraged strongly.

Furthermore, the interviewees highlighted **the importance of the cross-sectoral collaboration**: *"We are the university which probably interacts the most with the industry already, but we want to do even more if we have some energy"*. **The researchers are actively involved in this process as well by sharing their own contacts with TTO**: *"If the researcher knows people within the company, we will use that information to get into contact with the right person".* It is a common practice because the researchers *"are motivated to help us in the organizational process through their contacts"*. In this way the interaction with the industry is more efficient and leads to successful cooperation: *"It is something where we can help the researchers and the industry to collaborate more effectively"*.

To sum up, during the interview several factors influencing the performance of TTO at AAU were reasoned. First of all, the importance of relations among the actors in the innovation ecosystem. Personal networking is one of the best ways to start a close contact with the external stakeholders. Secondly, money is not the main result which should be expected from the technology transfer, but the social impact is. Thirdly, in order for TTO to perform successfully, common perception of the real value of the cross-sectoral cooperation between university and industry has to be achieved. Lastly, the understanding of the demands of the industry enables the researchers to shift their research field to the direction the results of which might be commercialized and implemented in the society.

4.4. Generalization of Empirical Results

In order to generalize the empirical results regarding the factors influencing the performance of TTOs, comparison of the cases is required. An international study was done in the context of ECIU. It consisted of mobility visit to TTO at Linkoping University in Sweden (including the semi-structured

interviews), ten structured interviews with representatives of TTOs and five additional semi-structured interviews with the leaders of TTOs. During the structured interviews the main factors influencing the performance of TTOs were identified. Meanwhile during the semi-structured interviews those factors were generalized and deeper analysis for the reasoning of them was done.

According to the assembled data, based on the answers of the interviewees, it was decided to evaluate the importance of each categorized factor influencing the performance of TTOs. ***1 point was given for non or bare existence of the fact, 2 - for average presence of the fact and 3 - for an existing fact. Symbol "/" means that no comments on that factor were made.*** The evaluation of related comments from the representatives of TTOs regarding the factors is summarized in Table 19.

Table 19. The evaluation of expressed opinions of the representatives of TTOs regarding the factors influencing TTOs.

Category	Subcategory	Tampere University of Technology	University of Aveiro	Aalborg University	University of Twente	Linkoping University	Hamburg University of Technology	TOTAL in Subcategory
Regional economy	Investors	3	3	3	3	3	3	**18**
	Governmental support	2	3	1	3	3	1	**13**
Organization design and structure	Unit of TTO working with students	3	3	1	1	3	3	**14**
	Unit of TTO working with researchers	1	3	3	1	3	3	**14**
	Unit of TTO working with enterprises	3	3	3	3	3	3	**18**
	TTO is a separate holding company	1	1	1	3	3	3	**12**
IP strategy and policy	Process management	3	/	3	3	3	3	**15**
	Following KPIs	3	/	1	3	3	3	**13**
	IP belongs to university	3	3	2	3	1	3	**15**

	TTO strategy	3	3	1	3	3	3	**16**
Human resource	Period of time worked as an advisor/manager	2	/	1	1	/	/	**4**
	Staff training	/	3	1	3	3	/	**10**
	Technical knowledge	2	3	3	1	1	1	**11**
	Business experience	3	3	3	3	3	3	**18**
Industry links	TTO marketing campaign	2	3	/	2	3	3	**13**
	Networking	3	3	3	3	3	3	**18**
	Marketing campaign for scientific products	/	3	3	1	3	/	**10**
	Industry analysis	/	/	3	3	3	3	**12**
Cultural	Researchers disclose the inventions	2	3	3	2	/	3	**13**
	Informal relations at the University	3	3	3	3	3	/	**15**

Based on the information provided in Table 19, five main factors influencing the performance of TTOs scored the highest results: **investors**, **unit of TTO working with enterprises**, **business experience** and **networking** collected 18 points out of 18, and **TTO strategy** - 16 out of 18. Comparative generalization related to the reasoning of these factors is discussed further.

First of all, **financial support from the investors** was identified as one of the most important factors. The interviewees provided various arguments regarding this factor, but they all as one claimed that **without financial stability there are no opportunities to develop new technologies and to increase the quality of research work**. To add, all the external funding usually comes from the private funds. Representatives from TTOs at the Universities of Linkoping, Aveiro and Tampere talked about such external investors as business angels and venture capitals. LiU Invest from Linkoping University

named that for the development of their internal technologies they gather the consortium of investors by using their personal network which helps to make perspective investments for the future technologies. Interviewee from the University of Twente revealed the fact that there are many early stage investors in the Netherlands who are willing to take a risk because they are led by curiosity, personal interests and prestige. In the case of TTO at Hamburg University, funding is provided by private regional SMEs and multinational companies. Moreover, the interviewees from Aalborg University also mentioned that most of the funding belongs to private funds and usually from international the U.S. based companies. Therefore, it is relevant to claim that private funding is critical for the effective performance of TTOs.

Second important influential factor is **relations with the enterprises**. There are many different ways how to start and extend cross-sectoral collaboration. In the case of LiU Holding AB, within the organization's structure there is a separate unit which is responsible for the communication with the industry in the region. TTOs at the universities of Aveiro, Tampere, Twente, Aalborg and Hamburg have people who are responsible for working with the companies. The management of the latter depends on what **strategy** TTO is following, in other words, what the general focus of TTO activities is. For example, TTO at Tampere University of Technology does not have the IP portfolio because there are no resources such as business developers who could commercialize patented technologies and search for licensing opportunities. Therefore, this TTO focuses on joint research projects with the industry, and, comparing to the other studied TTOs, it has the biggest number of R&D contracts between the researchers and the companies (according to the data from the structured interviews, 500 per year). Meanwhile TTOs at the universities of Twente and Aalborg were represented as focusing on bringing technologies to society by licensing or establishing spin-offs. Nevertheless, **industry liaison is a must because it is essential to know which needs companies have and which challenges they are facing**. **The latter can be solved by bringing novel inventions to the market, and at the same time benefiting the society with increasing economic growth.** In the case of TTO at Hamburg University of Technology, it provides services for all region because the municipality is one of the shareholders of this office. Therefore, TUTECH has a linkage role on the regional level, and hence the industry is stimulated to collaborate with it on the continuous bases. Thus, the practical examples illustrate that the strategic focus sets the path for the relations which influence the achievements on a broad scale.

To continue, in order to achieve the goals of TTO the specific competencies are crucial. All the interviewed representatives confirmed that **business experience** is an important factor influencing the performance of TTOs. This competence is vital because technology transfer process is consisting of many details which are business development oriented, and therefore, a person experienced in that field is of much value to any TTO. Representatives from TTO at Aalborg University specified in particular that **having economic skills allows to evaluate the inventions on the realistic scale avoiding, for instance, misjudgement in revenues**. To add, due to the possibility of more creative and original

outcomes the interviewees from TTOs at the universities of Aalborg, Aveiro and Linkoping distinguished **a diversity and a mix of people with different backgrounds as an added value for the team working at TTO**.

The business experience and economic skills are closely related to the next significant factor influencing the performance of TTOs - **networking**. All interviewees explained that to be a part of the network in the region is critical in order to successfully mediate between science and industry. Organizing and participating in the matchmaking events, exhibitions, innovation clubs, workshops and seminars is just one of the ways to establish new contacts and to stay close to the enterprises as well as to the members of university. However, **establishing personal networks based on trust and respect is the core of every solid technology transfer office**.

DISCUSSION AND GUIDELINES FOR LITHUANIAN CONTEXT

Based on the generalized results, several questions were brought up for the discussion related to Lithuanian TTOs context. First of all, several models of TTO exist in practice: i) TTO operating within university; ii) external holding company owned by university; iii) a combination of internal and external TTO; iv) external services bought by university in order to perform TTO function; v) external TTO with university(-ies), municipality(-ies) and other (if any) stakeholders as shareholders. As for today, in Lithuania there are only internal TTOs operating within the universities. Depending on many variables universities choose which model is the most applicable for the current situation because there are always arguments *for* and *against*. For instance, internal TTOs cannot generate revenues from consultations or events for the companies while external TTOs cannot get financed fully from the program Horizon 2020 because such type of TTOs are fully profit companies and the intensity of the projects covered by this European program for them is only 70 %. Another example, having an internal and external TTO can be convenient but at the same time - confusing because of the division of the tasks. Besides that, maturity level is an important factor having influence on the performance of TTOs. Hence, the fact of having regional TTO, the owners of which are several stakeholders (for instance, Kaunas University of Technology, Kaunas City Municipality and Kaunas District Municipality), implies the maturity level regarding technology transfer in the whole region. Thus, as *Lithuanian TTOs are newly established and therefore their maturity level is still at a juvenile stage, it is reasonable to strengthen the technology transfer process internally and only then start building on the most relevant model.*

Secondly, there are different opinions and perspectives regarding involvement of investors in the process of creation of new technologies. One of the attitudes is that as soon as external financing is involved, the creator of new invention loses control of the project, and therefore, conflict of interests starts. However, there is an opposite viewpoint which argues that without any financial resources new knowledge cannot be developed, and usually if investors support certain project it means that it has real potential and so it is worth an investment. However, most of the times venture capitalists are not willing to invest into projects which are only based on ideas and has no reasoning (for example, a prototype or research data results). Regarding this matter exceptional is the region of Twente where there is already even a competition among investors who want to provide their capital for early-stage radical inventions. They are taking a risk lead by their personal interests, and thus it is more related to cultural mindset and traditions developed over the time in that region. *Meanwhile culture of investment is only on the way to Lithuania, therefore, now it is the time to embrace it and bring forward by reaching out to venture capitalists and making them aware of what Lithuanian science is capable of. Money is not a challenge in this case, but the approach is.*

Thirdly, there is a wide discussion in regards of what expertise is needed for the employees of a TTO. In the most cases people with diverse backgrounds work at TTOs. However, it was noticed during the conduction of the research that business experience is especially needed. Nevertheless, it does not necessarily mean the experience from working at a company or getting MBA. It is more about having a real economic sense and being able to evaluate the actual potential of technology and market as well as to effectively assist in developing the inventions created by the researchers. Technology transfer specialists are operating in a process of sales, however, it is not a typical one because during technology transfer process both sides need to be taken care of - the one of the seller as much as of the customer. There are also arguments for the staff of TTOs having only technological background because understanding the technological aspects from basics is an advantage during commercialization process. Ideally, a perfect employee should have a mixed background, for instance, technological education and ownership of his or her own start-up. However, that is not a common case, therefore, any TTO should have a strategy for an employment period for its employees, meaning, that if a staff member lacks certain skills there will be conditions for him or her to gain them through, for instance, training courses, practical tasks, colleagues, etc. Moreover, self-evaluation could be used as one of the tools to assess the existing knowledge at TTO and to utilize it at the maximum on the organizational level. Therefore, *as till now Lithuanian stakeholders, involved in technology transfer process, used most of their resources on building up the infrastructure, it is relevant to start investing in human capital.*

Fourthly, as one of TTOs' functions is to bridge the gap between science and industry, it is essential to take part in networking activities inside and outside the university. Therefore, effective communication takes a crucial role in cross-sectoral collaboration, and trust is a key factor to achieve it. However, depending on the model of the TTO, some of them have the whole unit working directly and actively with the industry, some have a person responsible for the communication with the companies, and in some all the advisors are encouraged to get in contact with the industry in one way or another. Despite the structural arrangements, direct and indirect contacts between researchers and enterprises are a focus of any TTO. Therefore, it is closely related to the background and skills of the TTO staff because those, who are entrepreneurs and come to work at the TTO already having business experience, also bring their industrial perspective and personal network. In such a way they are as much a part of science world as a business one too. However, getting recognized by those two worlds takes time because gaining confidence is a constant and serious process. Hence, *there are several approaches which could be applied for Lithuanian TTOs in order to achieve trust and respect from their researchers and partners: i) to organize quality matchmaking events for researchers and industry based on active workshops which would be specified by relevant topic; ii) to establish and keep personal contacts with the scientists and people from business; iii) to strengthen the TTO's positions on internal and regional*

level, and only then proceed to international waters; iv) to be patient in the process of recognition and foster the connection because trust cannot be built over the night.

Finally, it is considered that technology transfer process should generate revenues, therefore, most of the times the performance of TTOs is evaluated through monetary KPIs. However, as this study revealed, such process reflects much more aspects than only money. For instance, societal benefit should be valued more than revenues for one unit within the society. Knowledge transfer is a long and specific process requiring constant effort from internal and external actors towards the result. For example, the representative from the TTO at University of Twente mentioned that it can take up to two years to establish a spin-off based on a new technology, and it involves such processes as coaching or finding CEO, finding investors, filing a patent, establishing partnerships on the subject matter, etc. For this reason, *in Lithuanian TTOs as well as in any other there should be more detailed qualitative evaluations conducted along with quantitative ones in order to assess their performance. Furthermore, strategic focus is what sets the direction towards certain goals. Therefore, it is significant to evaluate weaknesses and strengths of the university in order to distinguish which areas are worth to focus on in regards of commercialization of technologies. Based on that, the IP portfolio should be built up only for those inventions, which have potential to be brought to the market, as well as relevant legislative system should be prepared for the creation of spin-offs within the universities.*

CONCLUSIONS

Based on the theoretical literature analysis and empirical research performed, the following conclusions can be drawn:

1. *Following research of the presumptions regarding the performance of technology transfer offices, it has been concluded that:*

a) TTO is considered as a critical factor to result in success of the university and even the region in a broader context. TTO can be defined as an intermediary between academia and industry, ensuring resources for the development and exploitation of university's intellectual property by recognizing potentially commercializable inventions and identifying licensees and/or investors for them.

b) It is quite difficult to assess new and not mature TTOs (such as the ones established in Lithuania) in regards of whether all of them are contributing to faster and more efficient identification of scientific inventions and process of commercialization. The reason for that is the maturity level of the TTO. According to the existing literature, it is directly influencing the performance of TTOs, and the impact of such process cannot be expected earlier than after 10 years internally and even 20 - externally.

c) Monetary KPIs are used as a measure to evaluate the performance of TTOs because the predominant understanding of the role of TTOs is generation of revenues. However, recently scholars started suggesting that evaluation of non-monetary indicators is necessary as well because the added value of TTO is more comprehensive. Despite that, by identifying KPIs it is possible only to indicate the level of the performance of TTOs but not the influential factors due to which TTOs are at a certain level.

d) Even though there is a significant number of studies conducted on factors influencing the performance of TTOs, no study to date has classified them according to subject similarity. Based on this gap in the literature, six groups of key factors were distinguished: i) IP strategy and policy; ii) organizational design and structure; iii) human capital; iv) industry links; v) economic incentives; vi) cultural aspects.

e) So far, the performance of TTOs has been investigated from various perspectives, however, most of the cases have been based on the U.S. context. Furthermore, only several cross-country studies based on not more than three comparative cases on the performance of TTOs have been conducted up to now. Thus, based on this gap in the literature, the cross-country research was conducted in order to reason the factors influencing the performance of TTOs based in Europe.

2. Since the aim of the study was to see the internal situations through the practical insights of the representatives of TTOs at the members of ECIU, **qualitative research approach** allowed to obtain the results. By now the subject of this study has been investigated poorly, thus at this stage it was important

to understand the essence of the phenomenon and to grasp the trends. The approach revealed the nature of the phenomenon under investigation in its usual context.

3. *Based on the empirical research it can be concluded that:*

- There are five factors influencing the performance of TTOs the most: i) investors; ii) unit of TTO working with enterprises; iii) business experience; iv) networking; v) TTO strategy.
- The empirical study allowed to reason the identified factors based on international context. *Networking* was emphasized through the importance of continuous collaboration between university and business on an individual level. *A separate unit for relations with enterprises* was highlighted through the possibility to communicate operatively based on well-arranged structural arrangements. Comprehensive *strategy* in regards of the role of the university and the focus of TTO activities was reasoned through reaching common understanding of the need for university to establish such entity as a TTO. The role of *investors* was specified as essential because by creating infrastructure for innovation and sponsoring R&D activities this stakeholder enables an emergence of new technologies and thus is a critical actor in the whole commercialization process. To continue, *business experience* of the staff of TTO was discussed in relation with professional communication and the beneficial value for TTO activities. However, the diversity of backgrounds related to economic, technologic and law expertise was distinguished as an asset to the performance of TTOs.
- As the performance of TTOs remains a challenging topic for many universities around the world, the empirical research allowed to recognize the differences and similarities of TTOs established at the members of ECIU. According to the literature, mature TTOs perform more successfully than the newly established ones. This study confirmed such conclusion, and also revealed that they both are challenged by very similar issues. The difference is that the mature TTOs have created more experiences and gained more practice over the years, and thus they have more expertise in how to deal with certain challenges in an efficient way. Meanwhile not mature TTOs do not have such possibilities simply because of the timeline, therefore, learning from good case practices is essential for them. However, the research divulged that factors influencing the performance of TTOs are almost identical despite maturity level and country.

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